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INTERVIEW WITH J. EDGAR HOOVER

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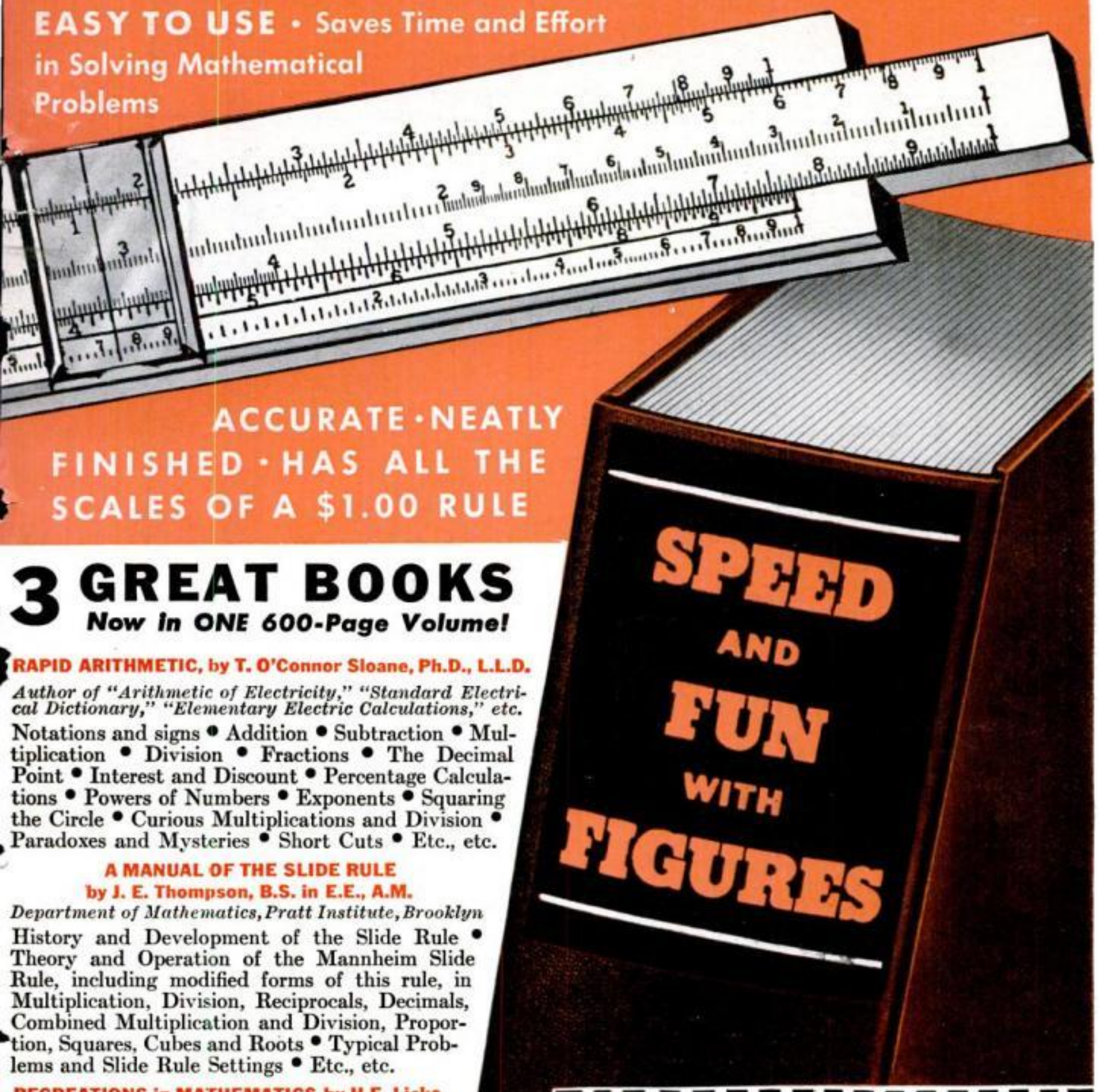

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Mechanics & Handicraft

THE NEWS PICTURE MAGAZINE OF SCIENCE AND INDUSTRY

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HAROLD W. KULICK, who took the pictures for "Testing the Hot Ships," page 52, was thrown from a motorcycle into photography. Laid up two years, he found a camera amusing and then good business. Specializing in the shooting of model planes, he graduated to full-scale aerials and branched out to other fields. He raises dogs, hunts, canoes, builds models,—and, of course, takes pictures.

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Can this happen to YOU?

It was the President talking—telling George that while he would like to give him the job—to promote him to an executive position, it was impossible to do so.

This was a bitter blow to George—he had known for some time there would be a vacancy in his department—the department manager was moving up—a new department head would be appointed. By seniority George was entitled to the job, had been counting on it.

It would mean more money—those unpaid bills would be taken care of—the children would have more advantages—there would be travel, recreation, social activities.

George had been a fine, loyal employee for twelve years—doing his assigned tasks well—hoping by faithful service to win some day an executive position with his company.

Now all of these hopes were being swept away—as in a dream he heard his chief continue—"You see, George, in these days it is ability to produce that counts. You're not ready to take on the bigger job—you have made no preparations which would enable you to fill it properly. The man who is going to get that job is Martin. He has been with us only four years, but during that time he has not only been studying the relationship of his department to the business as a whole, but he has been studying and preparing himself at home."

Poor George—no one to blame but himself. Business is full of "Georges"—men who do not realize the importance of preparing definitely for promotion. They forget that long experience on one job does not necessarily prepare them for the job above. And almost never do they reach the executive job and the bigger money.

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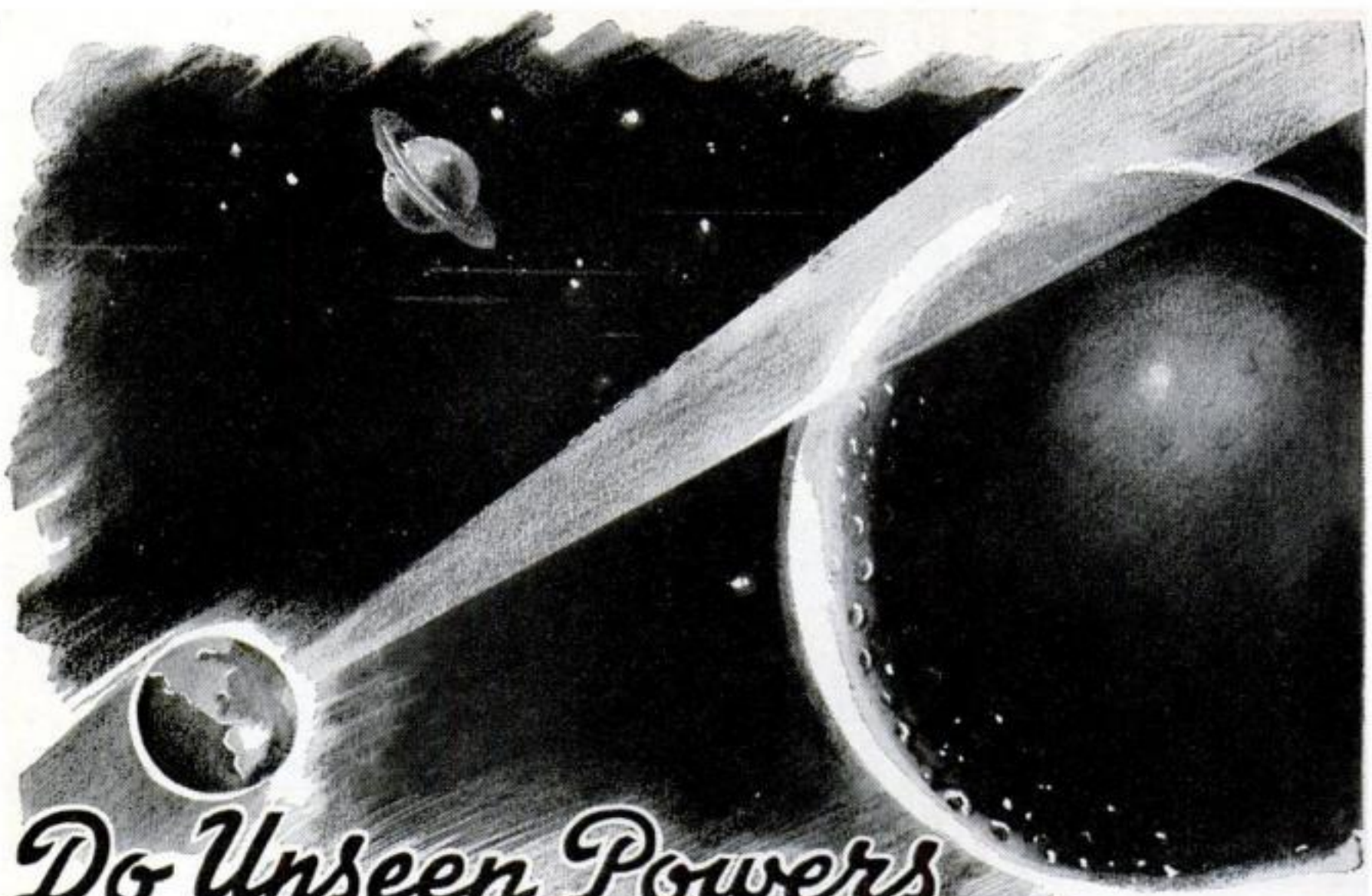

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I have been regularly employed in Radio since my graduation. I have been Chief Engineer of three broadcast stations, and at present time am Chief Engineer of WDOD. My salary has increased $1,800 per year since entering Radio and credit is given you for your excellent training.—JULIUS C. VESSELS, Station WDOD, Chattanooga, Tenn.

Makes $50 a Week

I am making around $50 a week after all expenses are paid, and I am getting all the Radio work I can take care of, thanks to N.R.I.—H. W. SPANGLER, 126½ S. Gay St., Knoxville, Tenn.

Extra Pay in Army, Navy, too

Every man likely to go into military service, every soldier, sailor, marine should mail the Coupon Now! Learning Radio helps men get extra rank, extra prestige, more interesting duty at pay up to 6 times a private's base pay. Also prepares for good Radio jobs after the service ends. IT'S SMART TO TRAIN FOR RADIO NOW!

Set Servicing pays many N.R.I. trained Radio Technicians $30, $40, $50 a week. Others hold their regular jobs and make $5 to $10 extra a week in spare time

Loudspeaker System building, installing, servicing and operating is another growing field for N. R. I. trained Radio Technicians.

FIND OUT ABOUT THIS TESTED WAY

Technician

$40, $50 A WEEK

WHY MANY RADIO TECHNICIANS MAKE $30, $40, $50 A WEEK

Radio is already one of the country's large industries even though it is still young and growing. The arrival of Television, the use of Radio principles in industry, Frequency Modulation are but a few of many recent Radio developments. More than 28,000,000 homes have one or more Radios. There are more Radios than telephones. Every year millions of Radios go out of date and are replaced. Millions more need new tubes, repairs, etc. Over 5,000,000 auto Radios are in use and thousands more are being sold every day. In every branch, Radio is offering opportunities for which I give you the required knowledge of Radio at home in your spare time. Yes, the few hundred $30, $40, $50 a week jobs of 20 years ago have grown to thousands.

BEGINNERS QUICKLY LEARN TO EARN $5, $10 A WEEK EXTRA IN SPARE TIME

Nearly every neighborhood offers opportunities for a good part time Radio Technician to make extra money fixing Radio sets. I give you special training to show you how to start cashing in on these opportunities early. You get Radio parts and instructions for building test equipment, for conducting experiments which give you valuable practical experience.

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This instrument makes practically any test you will be called upon to make in Radio service work on both spare time and full time jobs. It can be used on the test bench, or carried along when out on calls. It measures A.C. and D.C. voltages and currents; tests resistances; has a multiband oscillator for aligning any set, old or new. You get this instrument to keep as part of your N. R. I. Course.

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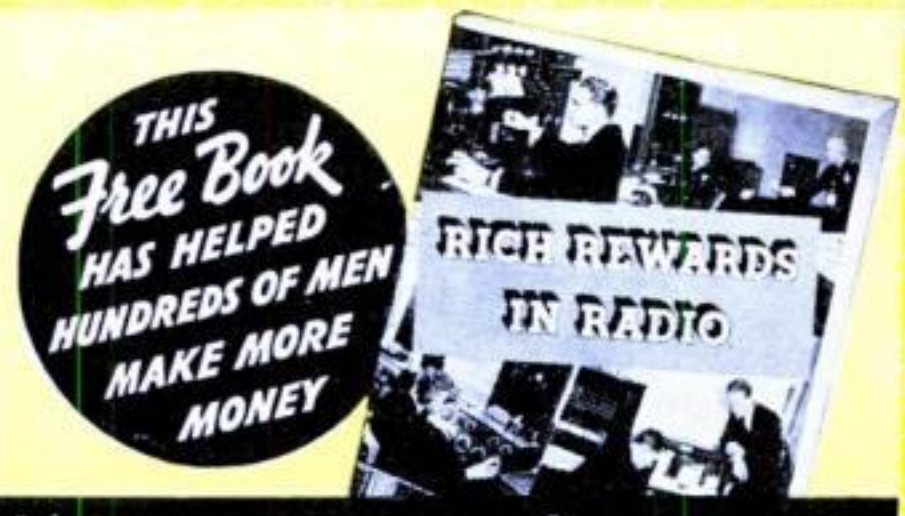
J. E. SMITH, President, Dept. 2BP3
National Radio Institute, Washington, D. C.

Radio Operators find good jobs with Government Departments, Shipping Companies and in Commercial Aviation; opportunities are increasing in these fields.

Broadcasting Stations employ N. R. I. trained Radio Technicians as operators, installation, maintenance men and in other capacities and pay well.



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Dear Mr. Smith: Mail me FREE, without obligation, your 64-page book, "Rich Rewards in Radio," which points out Radio's opportunities and tells how you train men at home to be Radio Technicians. (No salesman will call. Please write or print plainly.)

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TO BETTER PAY

From the News Editor's Desk

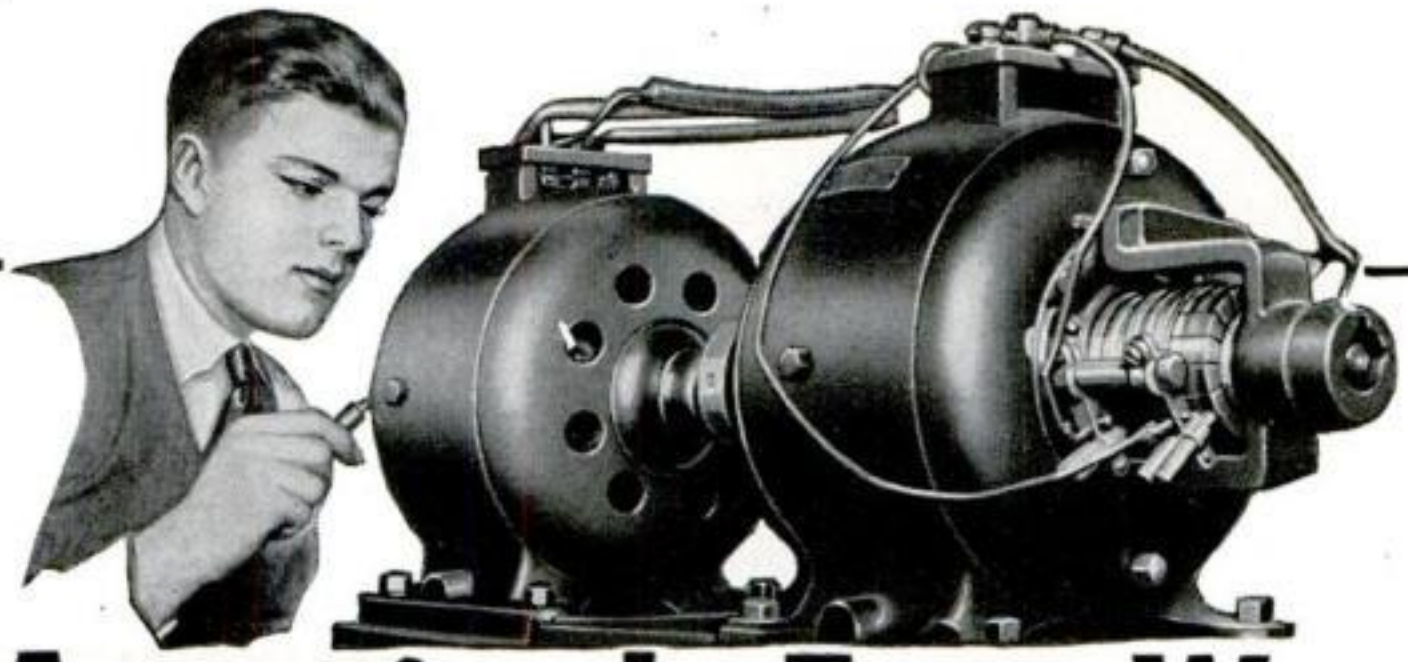
NATIONAL DEFENSE has become the keynote of meteorology in the United States. According to Prof. Charles F. Brooks of Harvard University, "nearly half of the time of meteorologists in the United States is being devoted to defense activities." Research problems are being dropped in order to accomplish projects for the Army and Navy. There are between 50 and 100 meteorologists among the instructors in the C.A.A. courses at 1,000 institutions throughout the country.

PLASTIC FABRIC has recently been developed for upholstery that is said to be stainproof, fireproof, and practically as tough as steel. Known as "Saran," this new fabric can be washed with soap and water and it does not retain heat like some chair covers. It can be produced in practically any weave or color and may be combined with silk, cotton, or other textiles. Saran is being tested on New York subways and is also being investigated by the U. S. Maritime Commission for upholstering furniture on new passenger ships. As it is made of a thermoplastic resin, its uses are expected to extend to table tops, airplane partitions, and room interiors.

A WATER-TIGHT SILK ENVELOPE, recently invented by a British Naval surgeon, can be placed over any burned or wounded portion of the body. The envelope is said to eliminate the need for changing dressings, a painful process and often detrimental to the patient. Manufactured to fit different parts of the body, this new envelope is frictionless and flexible, and may be secured to the wounded area by adhesive seals. It is painless to remove and, as it is made of transparent material, the wounded area is always visible.

NON-TERRIFYING GAS MASKS, made of transparent thermoplastic, are now being tested by the U. S. Army. Unlike old-type gas masks which give the wearer the appearance of a Martian monster, the new plastic mask allows the full face to be visible. Aside from its better appearance, it also allows clearer vision, is more resistant to all types of poisonous gases, and is equipped with a defroster which removes moisture inside the face piece. The black tubes, which are characteristic of many old masks, have been eliminated.

BY USING "HEAVY WATER," scientists at the Bureau of Standards have succeeded in producing a more constant standard volt. In heavy water, the two atoms of hydrogen that combine with one of oxygen, are twice as heavy as in ordinary water. Its use in the liquid part of the standard cell not only produces a more constant voltage, but it also eliminates an aging process that was necessary in the cells when ordinary water was used.



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Lack of experience—age, or advanced education bars no one. I don't care if you don't know an armature from an air brake—I don't expect you to! It makes no difference! Don't let lack of money stop you. Most of the men at Coyne have no more money than you have. That's why I have worked out my astonishing offers.

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If you need part-time work to help pay your living expenses I'll help you get it. Then, in 12 brief weeks, in the great roaring shops of Coyne, I train you as you never dreamed you could be trained...on one of the greatest outlays of electrical apparatus ever assembled . . . real dynamos, engines, power plants, autos, switchboards, transmitting stations...everything from doorbells to farm power and lighting . . . full-sized . . . in full operation every day!

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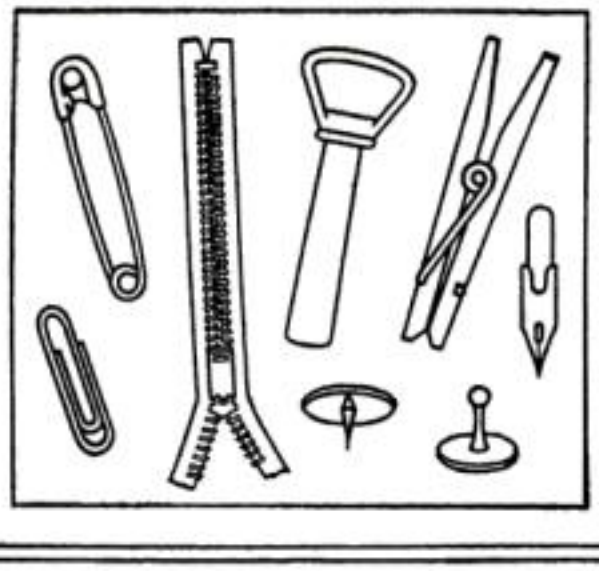

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Registered Patent Attorney before U. S. Pat. Office

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Readers Say:

Mysterious Chemical Reaction on a Linotype Machine

HERE'S a problem for the know-alls to solve. Being a linotype operator, I decided the other day to print some identification slips to paste on the steel covers of the magazines that hold the mats—brass pieces on which the letters are molded in a linotype machine. Well, I pasted these printed strips on the covers with rubber cement and covered them with Scotch cellulose tape to keep them clean. A couple of hours later I discovered that these strips had turned a beautiful pea-green color. The next day, they were white again.—D. P., Sheboygan, Wis.

That Time Our Proofreader Flunked the Question Bee

I WAS rather surprised to note that in your Question Bee on page 126 of the January issue you announce that "A patent is of practically no use at all." (Question 4, answered on page 220.)—H. L. E., Indianapolis, Ind.

That's one on us, H. L. E. A typographical error is responsible. We got the letter "b" in the answers column, instead of "c". The correct answer, of course, is "A patent is evidence that may be successfully contested by an earlier inventor."—Ed.

Some Skunks Do, Some Don't Seems to Be the Answer

IN THE "Readers Say" section of the December P. S. M., R. A., of Wilton, N. H., does not agree that anyone cannot be scented while holding a skunk by the tail with the hind feet off the ground. I wish to say that I disagree with *him*. I have caught several skunks and carried them for short distances by the tail, and have never been scented. Perhaps R. A. was just unfortunate in getting a hold of the one in a million, so to speak. I also have a witness to prove the above statement.—A. J. K., Medina, N. Y.

He Won't Let Us Let Him Let Us Stop Sending P.S.M.

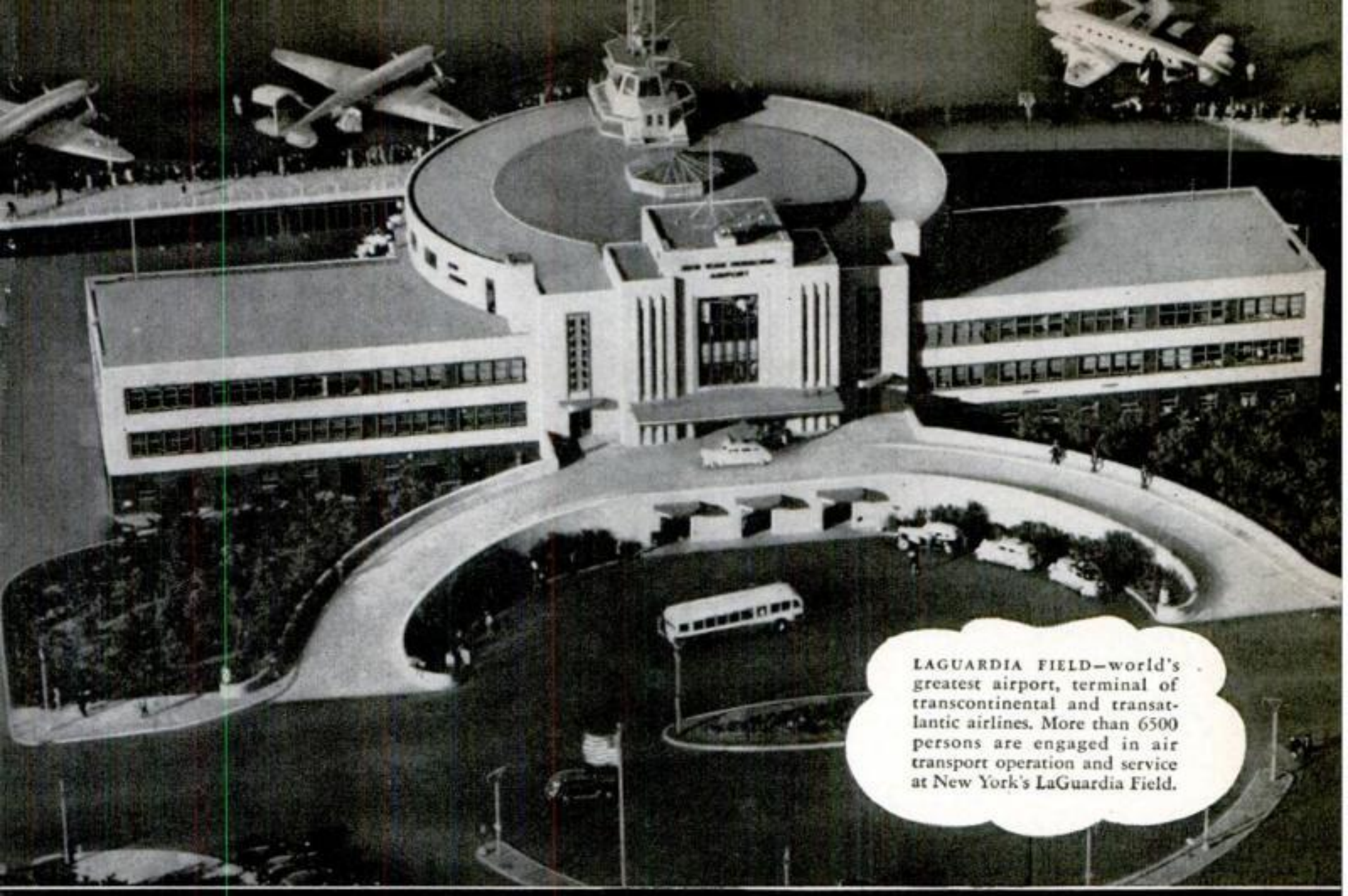
HERE'S your two bucks and fifty, and I consider it a doggone good investment. Your handy hints save me more than the cost of your magazine, and I'm a lazy fellow. Your articles of informative matter are fine. In fact, when I pull out some of my old copies (1920, 1922, etc.) and compare with today, I find you're improving so much I've no suggestion to make. Only one thing I ask: Don't let me let you stop sending me P. S. M.!—A. B. M., Badin, N. C.

That Wasn't A Projectionist —That Was an Operator

MAY I correct G. B., of Riffle, W. Va., on the statements he made in this column based on the mistakes of his local movie operator? The person of whom he talks is truly an "operator." That title is for beginners in the field of projection, or men who never get beyond the beginner stage. A real projectionist carefully inspects each program in advance, making sure it is in good condition. Any projectionist who has inspected his entire program, and is wide awake, never treats the patrons to the mistakes that G. B. describes. My deepest sympathy to G. B. and others who have "operators" in their home theaters.—P. R. B., *Projectionist*, Madelia, Minn.

Gus Says: That Sign Is Meant for the Customers Only

YOUR attention is called to pages 134 and 135 of your October 1941 issue. Shown in the illustration is a sign, "No Smoking," while on the next page the caption reads, "Gus fired up his pipe" etc. Perhaps in this repair shop the proprietor is immune to the rules or the law, but it looks like one on you chaps. I enjoy your publication and wish you success.—W. M. L., Port Washington, N. Y.



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Readers Say:

Fireplace from P.S.M. Plans Warms Jungle Nights

MANY thanks for the article "From Barnstorming to Bombers"! I was specially interested in it because this country owns many Martin-built planes. I appreciate very much the articles now appearing in P. S. M. describing the U.S. Army, Navy, and Air Force. I also like the Gus Model Garage features. Many ideas published there have been very useful to us. Some time ago we decided to build a fireplace in our jungle bungalow, as it gets rather cold there. (In the tropics a temperature of 28 degrees F. is frigid!) We used the plans that appeared in P. S. M. about a year ago, and I wish to thank you for them because the fireplace is really good. No smoke gets into the room, even when there is some wind blowing. P. S. M. is tops with me and I'm always glad to see it lying in the mailbox!—J. V. P., Malang, Java.

P.S.M. Is Money in His Pocket and Knowledge in His Head

I'M ONE of those mechanically minded fellows, and because of my knowledge of mechanics and science the boys call me "the Professor." With P. S. M. I have obtained enough facts on up-to-the-minute mechanics that I can out-argue almost anybody I meet. I recently won a dollar bet by telling a fellow that I could keep ice from forming on the wiper-blade area of his windshield. He thought I was nuts. So I applied a thin coating of castor oil to his windshield without his knowing it. After a trip, he was surprised to find that ice did not stick to the wiper area. Now the guy wants me to fix every little thing that goes wrong. P. S. M. sure puts guys in the good. Now I can't convince him that I'm not the only mechanic in the world to fix his truck. Well, that's why I can't be without P. S. M. It sure is money in my pocket and knowledge in my head.—W. R., Mount Vernon, N. Y.

Here's the Dope on Keeping Your Fishing Worms Alive

IN ANSWER to A. K., of Chicago, Ill., who wants to know how to keep worms alive between fishing trips: Take a barrel, put it in a cool place, and fill it with dirt—the kind from which you dig the worms. Put the worms in and feed them with coffee grounds, rice water, and drainings from vegetables. This will keep them alive, and they multiply. You will be surprised how much fine bait you will always have.—Mrs. I. M., Savonburg, Kans.

TELL A. K. to put his worms in the ice box. They will be quiet and need no feed.—M.B.H., Port Austin, Mich.

He Caught One of Those Tricks in a Western Thriller

READ your interesting article, "Inventions Add Thrills to Western Movies." A few days later, I saw a western and watched for some of the tricks. One that I caught was the controlling of a "driverless" team through a hole in the front of the wagon. I read your magazine regularly and enjoy Gus and the Model Garage a lot. You are publishing a great magazine—keep it up!—J. A., Aliquippa, Pa.

Diophantus Would Have Died Figuring This One Out

HERE is a little problem in mathematics: It is stated that the epitaph of Diophantus, an ancient Greek mathematician, reads as follows: "Diophantus passed 1/6 of his life in childhood, 1/12 in youth, and 1/7 as a bachelor. Five years after his marriage was born a son who lived only half as long as his father and died four years before his father did." How old was Diophantus when he died?—B. W. C., Jr., Concord, N. C.

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WELDS BUMPERS, FENDERS, CYLINDER BLOCKS, BODIES, FRAMES, ETC. Does Farm, Factory and Home Repairs

Many welders make as much as $15 to $20 a day. Repair jobs that can be done in less than an hour can make as much as $5.00. Any number of jobs can be done more efficiently with welding. The DYNAMIC Super-Charged Welder, despite its serviceability, is so easily portable it can be carried around by hand and taken right to the job. This is an added feature whose value you will appreciate once you are in welding.

WORKS ON IRON STEEL, TIN, BRASS, COPPER, AND ALL OTHER METALS

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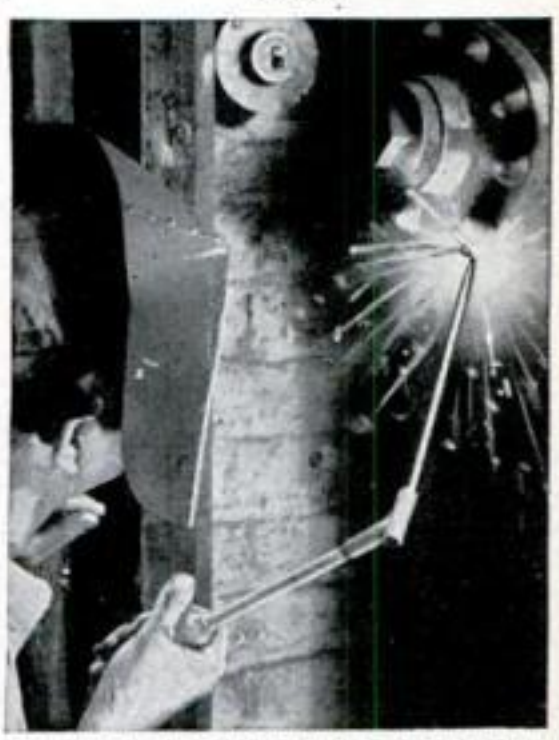

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IS YOUR CAR GOOD FOR 150,000 MILES? Yes, indeed, says Earl Cooper, former racing driver and now an experimental engineer engaged in building longer life into modern automobiles. This expert gives you practical tips on grooming your car for a long and useful career.

SUNLIGHT WHERE YOU WANT IT is the theme of an article for amateur photographers by Tony Gaudio, veteran Hollywood cameraman. He tells how to make and use reflectors to get well-rounded pictures in both stills and movies. Hitch the sun to your camera!

SUBMARINES, striking without warning, can sow destruction in crowded harbors and defense areas. How are our strategic seaboard cities and naval bases guarded against this insidious menace? What are the precautions and counter-weapons? These questions are answered in an authoritative article.

TYING FLIES can be as much fun as fishing with them. To introduce beginners to this fascinating and profitable pastime, Ray Bergman, Angling Editor of "Outdoor Life," gives complete instructions covering the tools and materials needed, the tricks of the art, and a play-by-play account of the making of one of the most popular dry flies, the Fan-Wing Royal Coachman. Fishermen will go for it hook, line, and sinker!

WAR MOVES FAST these days, and fighter planes, with their limited operating range, have to keep right up with the line of battle. William Morris, staff photographer, made a special trip to get exclusive pictures showing how the U. S. Army builds a temporary landing field in a jiffy as a nest for the hornets of war.

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R. E. BRANDEL, Editor

They Keep On Earning Money by Easy Electroplating

THE MAN who dreams of earning extra money, as much as $50 or $60 per week, need not dream in vain. Brush electroplating offers that opportunity. Here's what Jasper Brown of Chicago says: "I bought my electroplater to experiment with during my spare time. In a few evenings I earned the cost of the machine by plating jewelry, silverware, headlight reflectors, etc., for friends and neighbors. Now I have all I can do. I recommend this machine to all who want a profitable business."

Jasper Brown is headed for a business of his own, apparently. Restaurants, music stores, doctors, dentists and garages are only a few of the many sources of business for the electroplater who wants to hear more cash jingling in his pocket.

J. J. Wilson, Slidell, La., writes: "After I received my electroplater I practiced for about an hour. I made up four samples and went out after business. One of the large chain restaurants now has me do all their silverware."

Max Hemmert, Idaho Falls, Idaho, states: "I am now spending all my time in plating work. I purchased a brush plater last summer and have worked up a very promising business."

Frank Welde, Philadelphia, goes after garage business. He writes: "I electroplated a few brass strips for samples. I then showed these strips to different people and that's how I got plenty of jobs. I have all the work from a big garage. The owner gets 10% of what is charged his customers, and the rest goes to me for my work."

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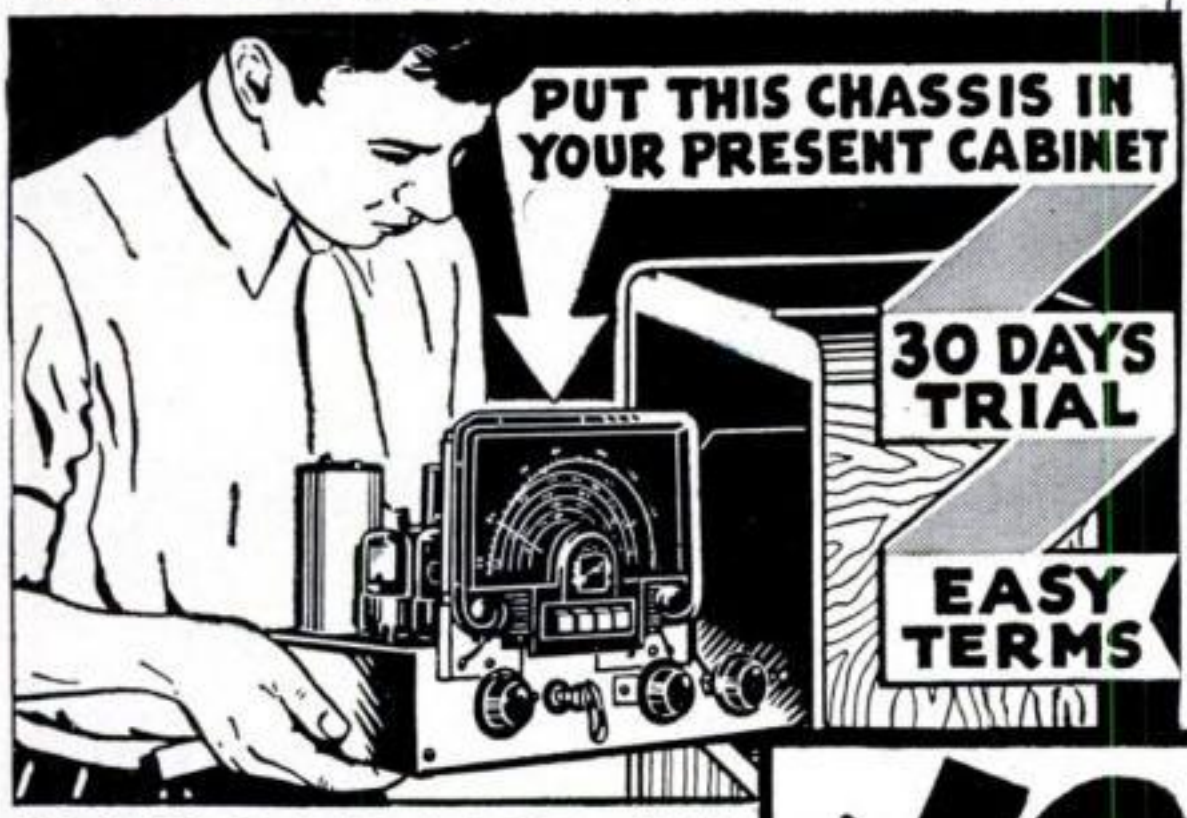

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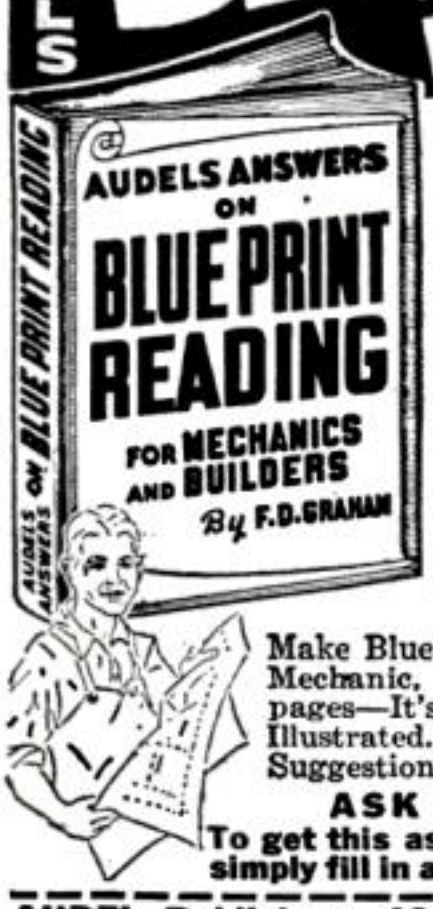

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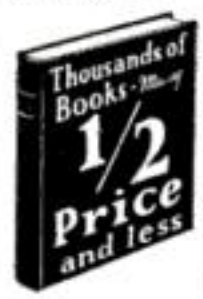

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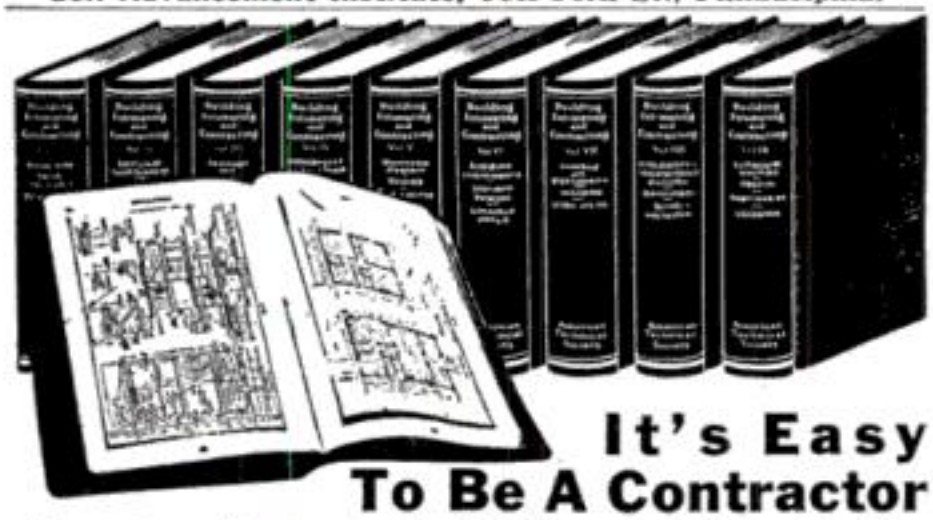

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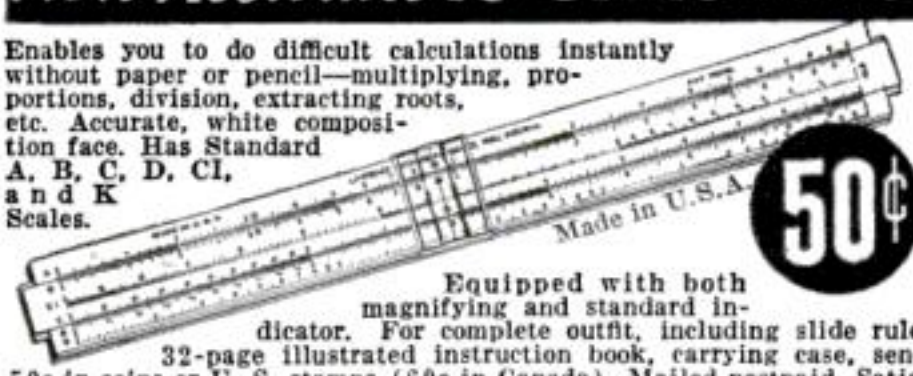

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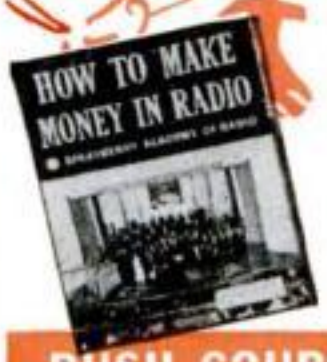

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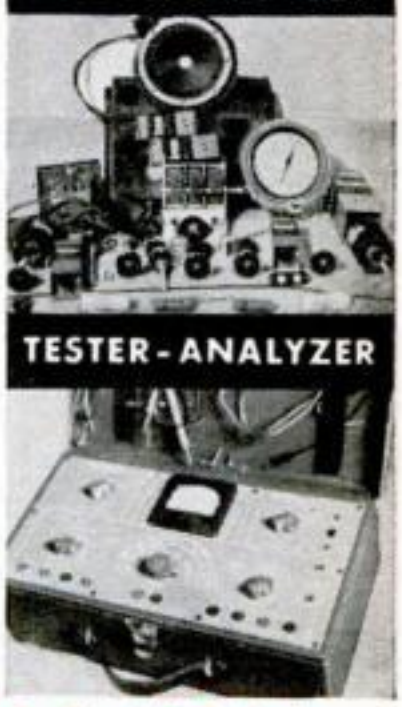

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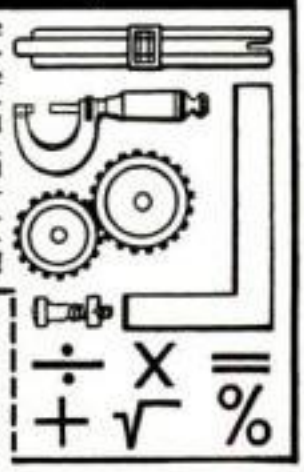

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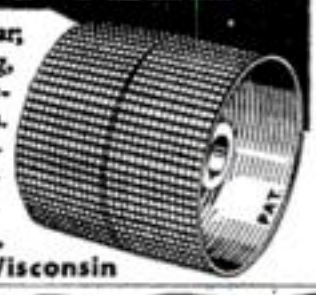

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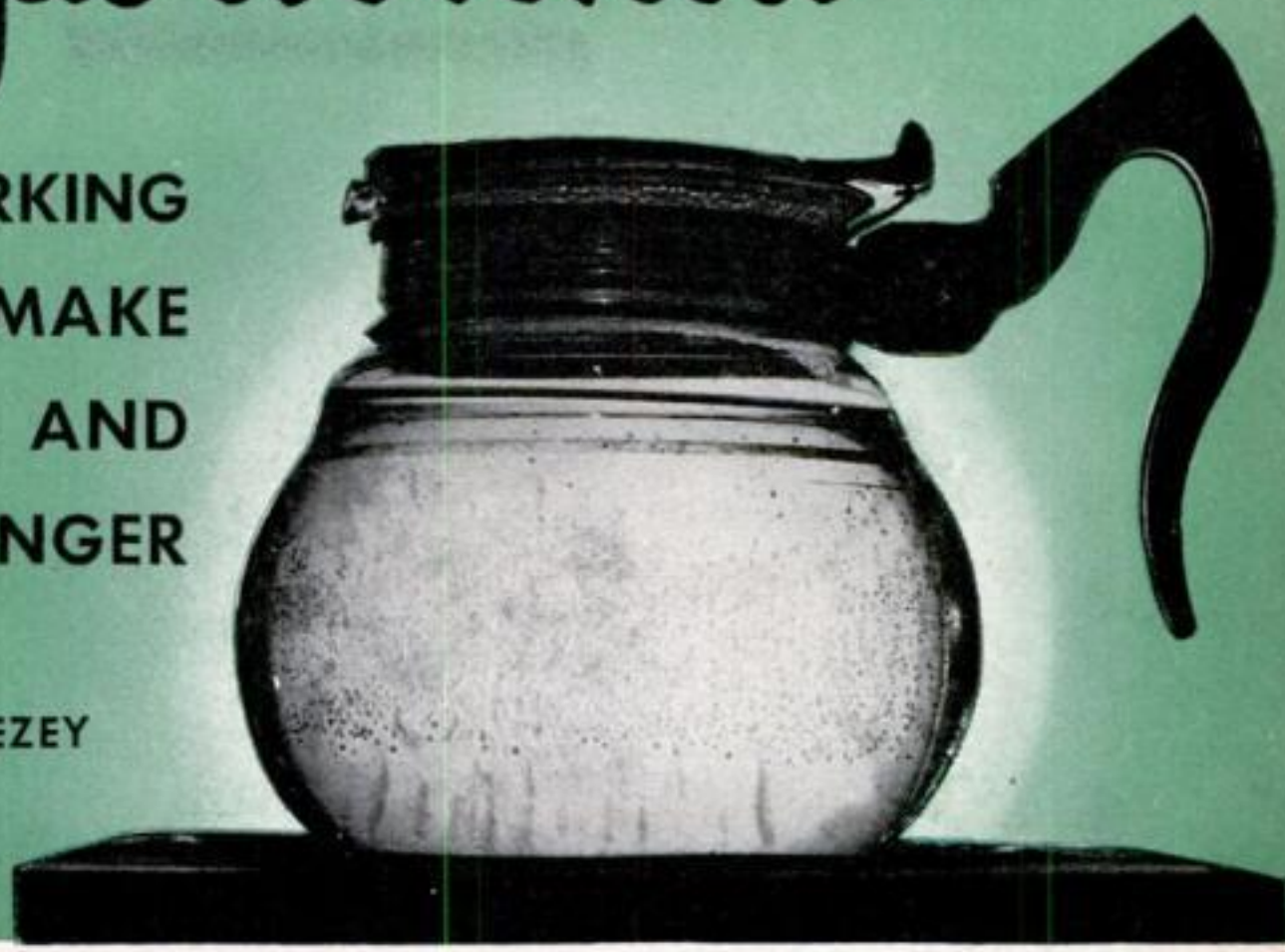
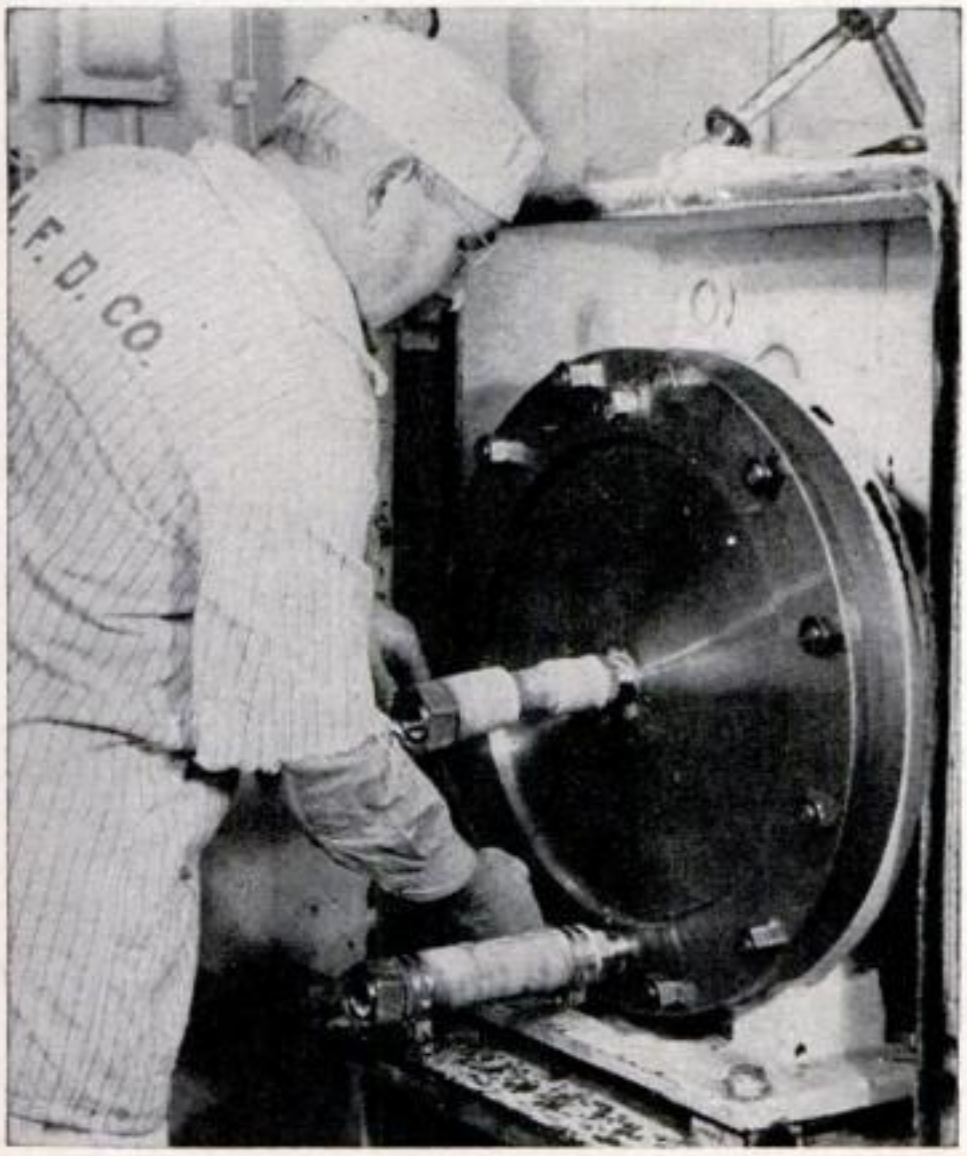
By
KENNETH M. SWEZEY



A TEAKETTLE "SINGS" because of cavitation—the collapsing of minute vapor bubbles. The same effect, produced in milk by piercing, 360-cycle sound waves, blends milk and cream molecules into a soft curd that stays fresh and is easily digested



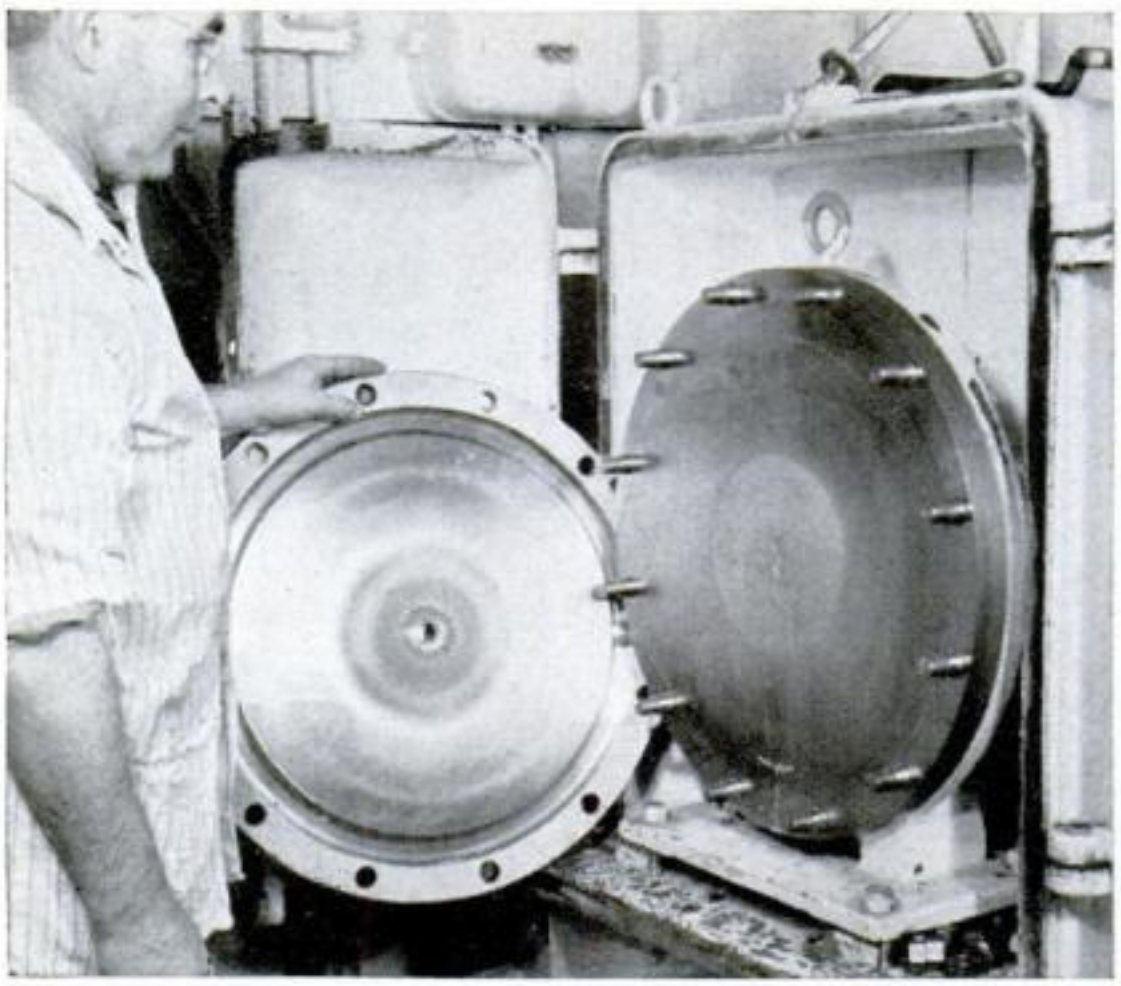
Sound oscillator used at Arden Farms Dairy, Arden, N. Y., for homogenizing milk, which is pumped in through the lower pipe at 250 gallons per hour

SOUND WAVES too powerful for the human system to bear, and others too high in pitch for the human ear to hear, are new miracle-working tools in science and industry. In dozens of laboratories, scientists are perfecting sound-generating devices, and discovering new uses for supersound and ultrasound.

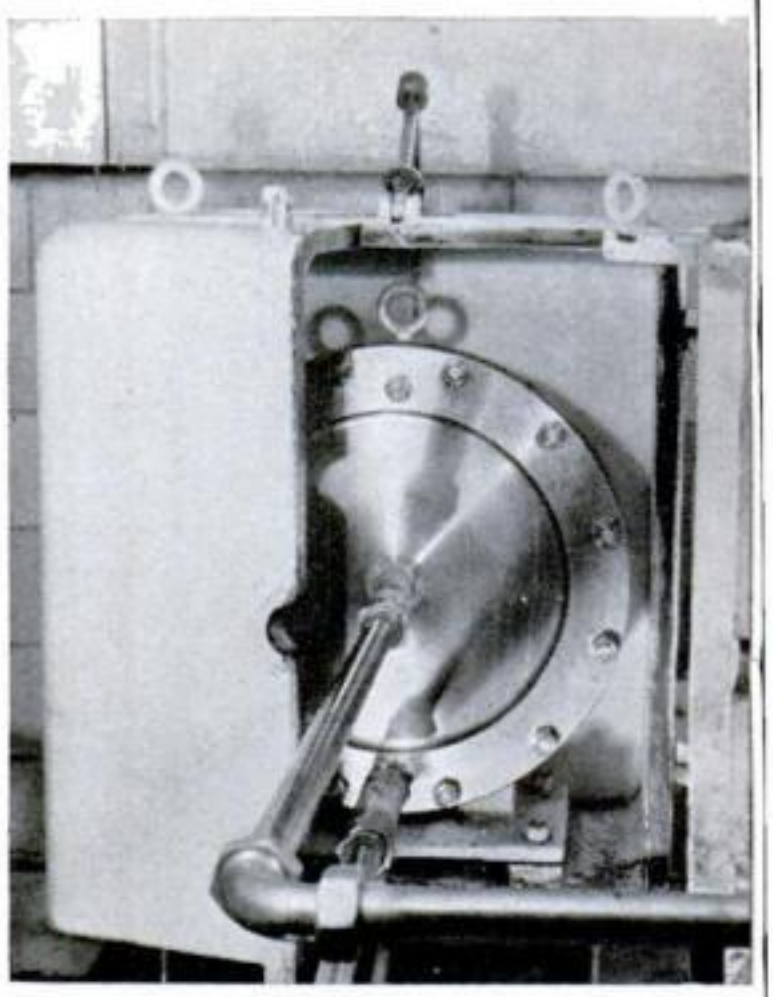
Already, intense sound waves are being used to homogenize milk and ice cream, mixing the milk and cream molecules and producing a soft curd product that is easily digested by infants and invalids. They kill bacteria in food, and help extract antigens from viruses to aid in the fight against infection. They are being used to help eliminate factory smoke and fumes.

In the laboratory, these strange vibra-

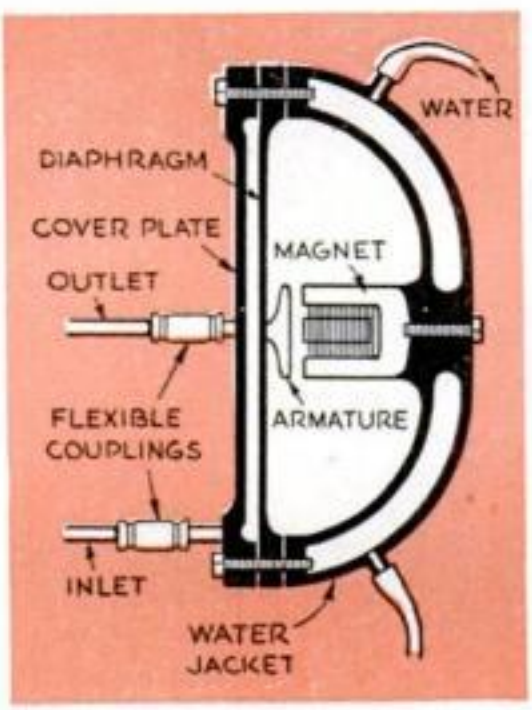
In this photograph, the jar at the left contains curd from sonically treated milk; the jar at right, large, tough curd from untreated milk of same kind



Sound oscillator with cover plate removed to show diaphragm. The central disk is the area in which the milk is most strongly vibrated



A casing of iron 1½ inches thick covers the oscillator to deaden the sound and prevent any possible harm to workers



How the sonic oscillator works. It is a big brother of the instrument used for echo sounding

tions speed up chemical reactions, cause ordinarily immiscible substances to mix, and even change one chemical substance into another as if by magic. Supersound weds into an emulsion such drastically unmixable liquids as mercury and water. Starch is transformed into dextrin, and water into hydrogen peroxide, merely by oscillating them with silent sound.

Treated with ultrasound, molten metals set more quickly and with a finer grain structure. Metals which ordinarily will not mix are readily emulsified by sound vibrations, enabling the creation of "impossible" alloys. Ultrasonics may simplify plastics making by providing a more homogeneous mix and speeding up polymerization, the combining of small molecules into larger and more complex ones. European industry has already used supersound to produce finer-grained photographic emulsions.

The testing of metals is another potential use of ultrasonics. Iron, steel, aluminum—all metals, in fact—are good conductors of these waves. Defects in the metal, however, such as cracks and blowholes, absorb or deflect the waves. By suitable instruments the defects may thus be traced.

The name supersonic may be applied to all waves powerful enough to produce marked chemical and physical reactions, and ultrasonic to vibrations above 20,000 per second, the general upper limit of audibility. Beyond audibility continue the ultra or soundless sounds, which may be produced by electrically vibrated quartz crystals up to several million vibrations a second.

Piercing, 360-cycle waves, emitted from a stainless-steel diaphragm vibrating with the power of 2,000 radio loudspeakers, are used in homogenizing milk—the first big industrial application of supersound in this country. Developed by the Submarine Signal Company, Boston, the oscillator used for the purpose is a giant brother to the oscillator used in echo depth-sounding in hundreds of ships. About two feet in diameter, its working parts consist essentially of a steel diaphragm and cover plate, each carefully tuned, vibrated by a magnet energized with 5½ horsepower of 180-cycle electric current.

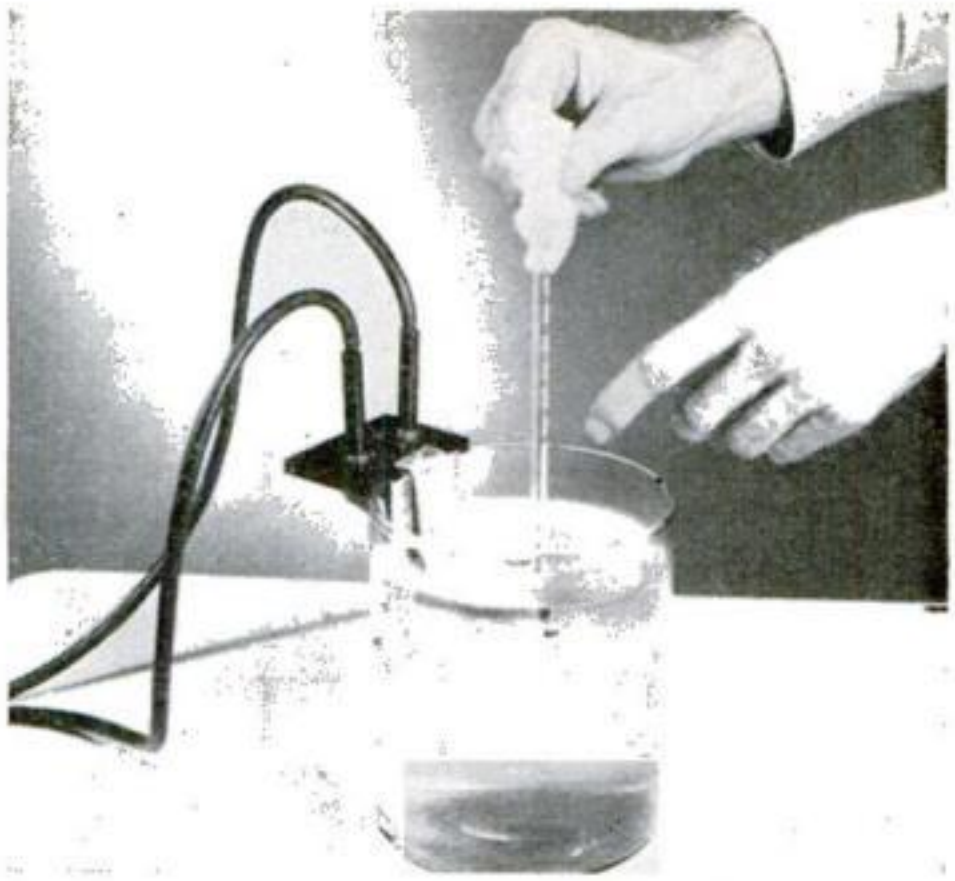
Before treatment, the milk is pasteurized as usual for 30 minutes at 145 degrees F. It is then pumped through the oscillator at a rate of about 250 gallons an hour. Entering near the edge, the milk passes between the diaphragm and cover plate and leaves at the

center, where it is most powerfully vibrated.

According to Dr. Leslie A. Chambers, researcher of the Johnson Foundation of Medical Physics, University of Pennsylvania, sound waves are able to homogenize milk and perform a hundred other feats of physico-chemical magic by means of what is known as cavitation—the formation and sudden collapse of minute vacuum bubbles in a liquid, produced by the rapid stretching and compression brought about by the powerful wave movements. In sonically vibrated liquids the force of cavitation tears particles apart and draws them through each other, producing amazing transformations.

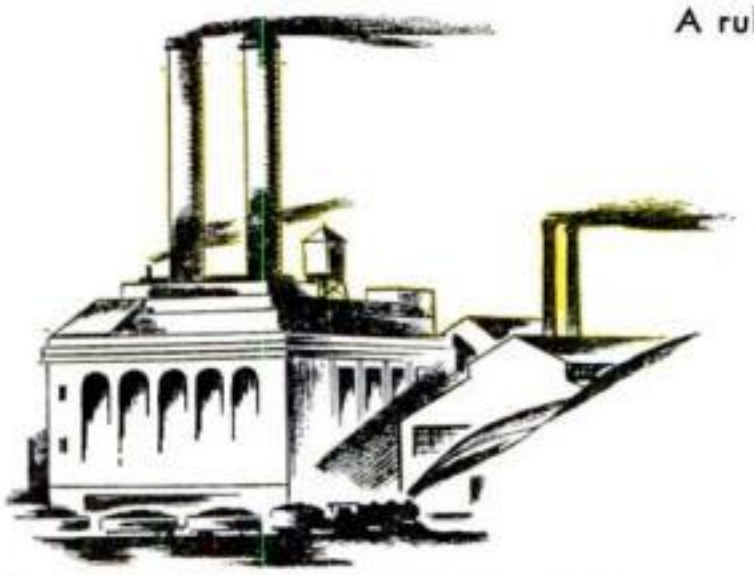
Dr. Chambers is now squeezing valuable antigens out of cultures of disease germs by means of ultrasonic waves. Previous methods for obtaining them involved heating, or the adding of chemicals, which destroyed some of the more sensitive antigens. By subjecting germs to a bombardment of ultrasonic waves, the germs are killed, and the unharmed antigens are separated by whirling the fluid in a centrifuge.

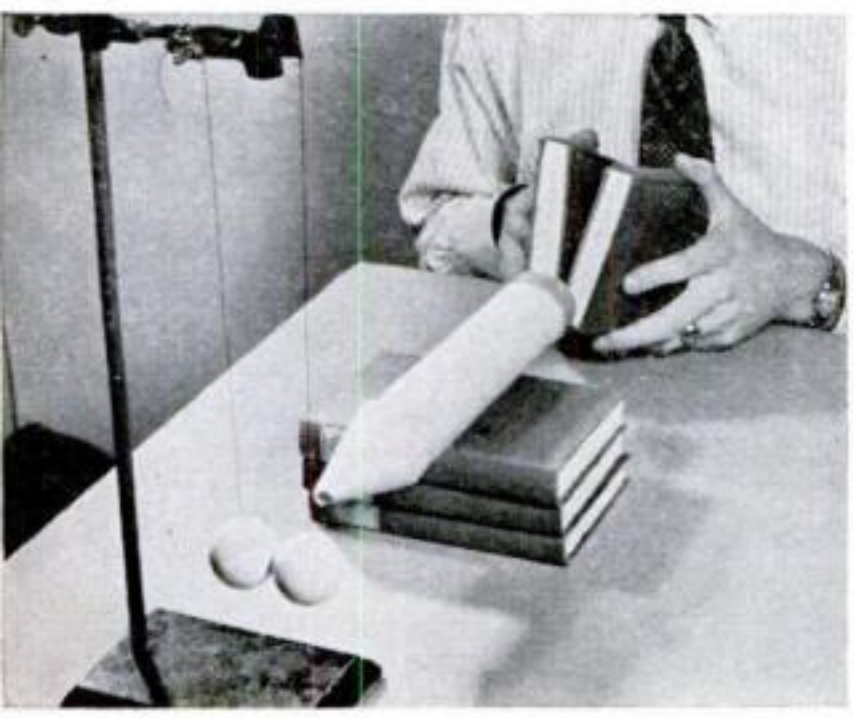
Another great possibility for ultrasonic waves lies in medical diathermy. Put a thermometer in a bath of oil being vibrated by these waves and, although its own reading indicates that the oil temperature is little above that of the room, the thermometer will burn your fingers! The reason is that the thermometer, being of rigid material, vibrates in step with the oil while your soft flesh does not.



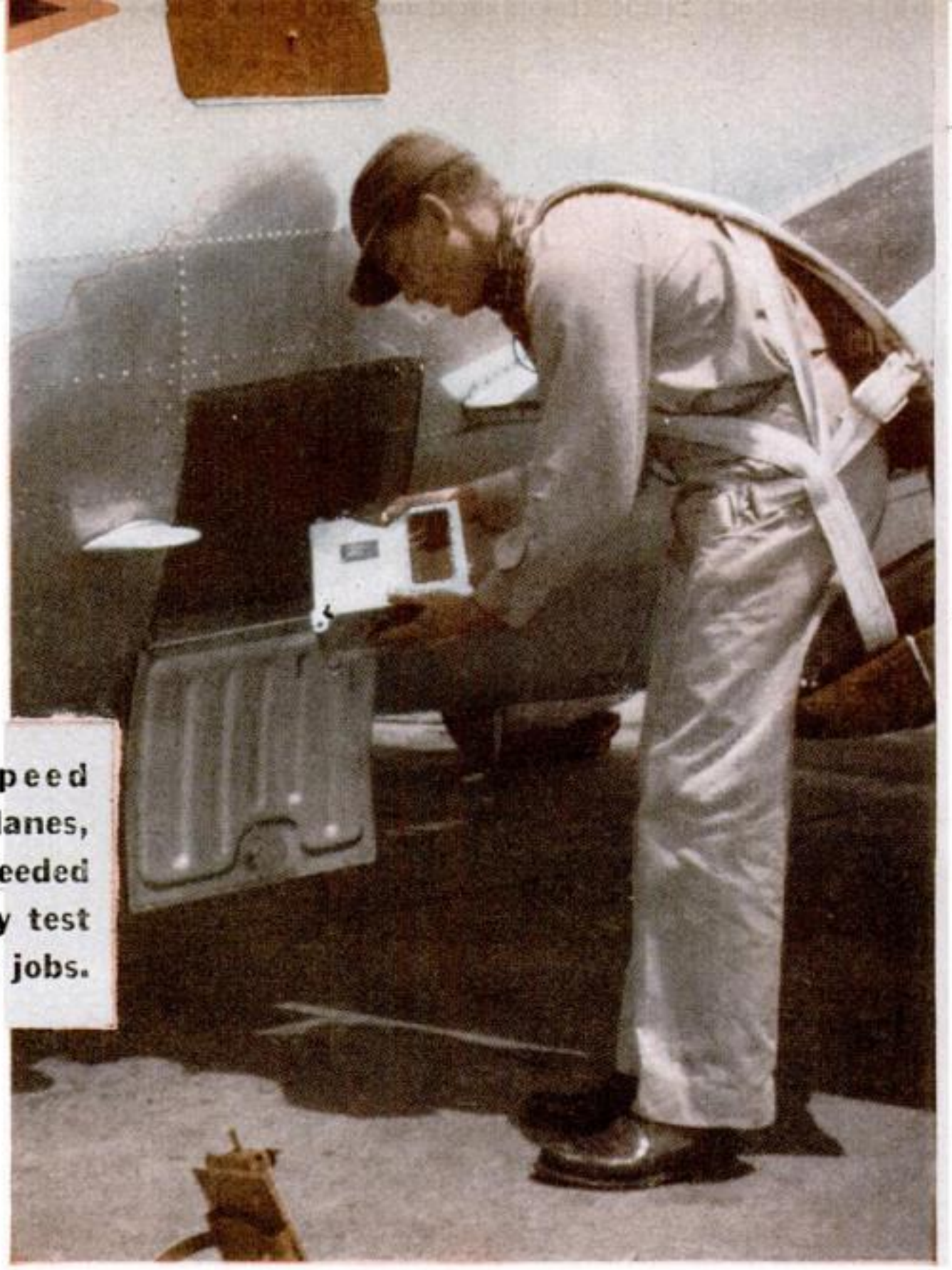
Oil vibrated by sound waves burns the finger, though a thermometer in it registers room temperature. This points to the use of supersonics in medical diathermy

How supersonic waves may precipitate factory smoke. A rubber diaphragm covers the end of the tube below





When the books are clapped together, the diaphragm sets up vibrations in the tube. These pass between the balls, drawing them together. Soot particles so combined would fall



With more and more speed being built into fighting planes, "pilots with a knack" are needed to master them. The Army test pilot is a man with many jobs.

Lieut. Marcus F. Cooper stows his barograph in the baggage compartment of a plane before making a practice test

Testing the Hot Ships

By HICKMAN POWELL

EVERY now and then in the Army Air Corps there turns up a young pilot who has a special knack with airplanes. As his talent is recognized, word gets around that here is a sweet flyer.

Often the same fellow has an equally outstanding love for flying, which, after five, six, or seven years, may be statistically demonstrated. While other pilots have flown hundreds of hours, he has flown thousands. He has been in a plane at every opportunity, adding to his experience and skill.

If this same superflyer is also endowed with an unusual degree of mental and emotional stability, older heads in the Air Corps exchange nods; shortly thereafter, the aviator receives orders to proceed to Wright Field, Dayton, Ohio, to become a test pilot. He has hit the top flight in the flying profession.

To a man who loves airplanes, in an Army whose average pilot is still wishing for just one really up-to-the-minute plane to fly, an assignment to Wright Field is something like a ticket to Paradise—and not by the crash route.

Your average tactical pilot flies a pursuit plane, a bomber, a transport or observation ship. But the test pilot flies everything, and always the latest model. All good planes go to Dayton before they go anywhere else; and the test man must be ready

Lieutenant Cooper: He was transferred from a pursuit group

Reporting for duty at Wright Field, Dayton, Ohio, he meets Lieut. Col. Stanley Umstead, the chief of the Army's test pilots

Lieutenant Cooper watches for his name to appear on the assignment board. During his three-month practice period he makes standard tests on planes whose performance is already known

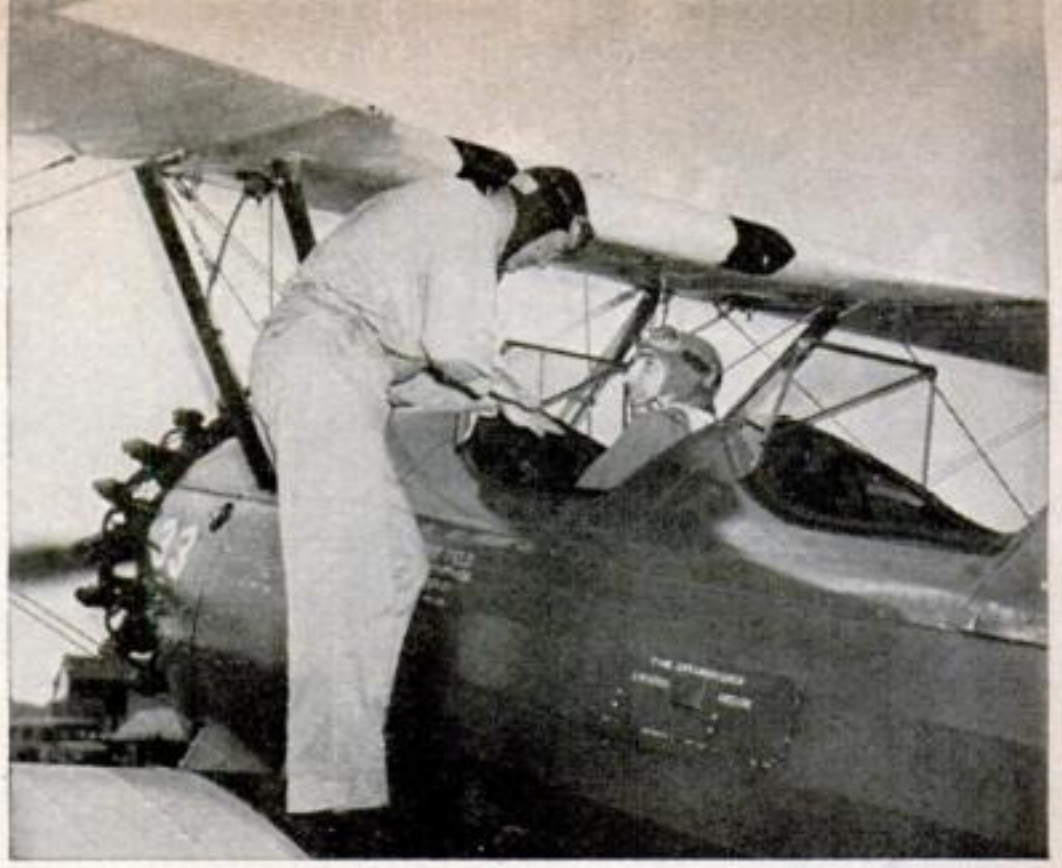
When his plane is ready, he gets into his parachute harness and other flight gear. Each pilot has an individual locker with his name in big letters on the door. Here he keeps his personal flight equipment

Ready to go, he checks out at the operations desk. A careful record is kept of all ships taking off and arriving at the field, so that each craft can be accounted for at all times

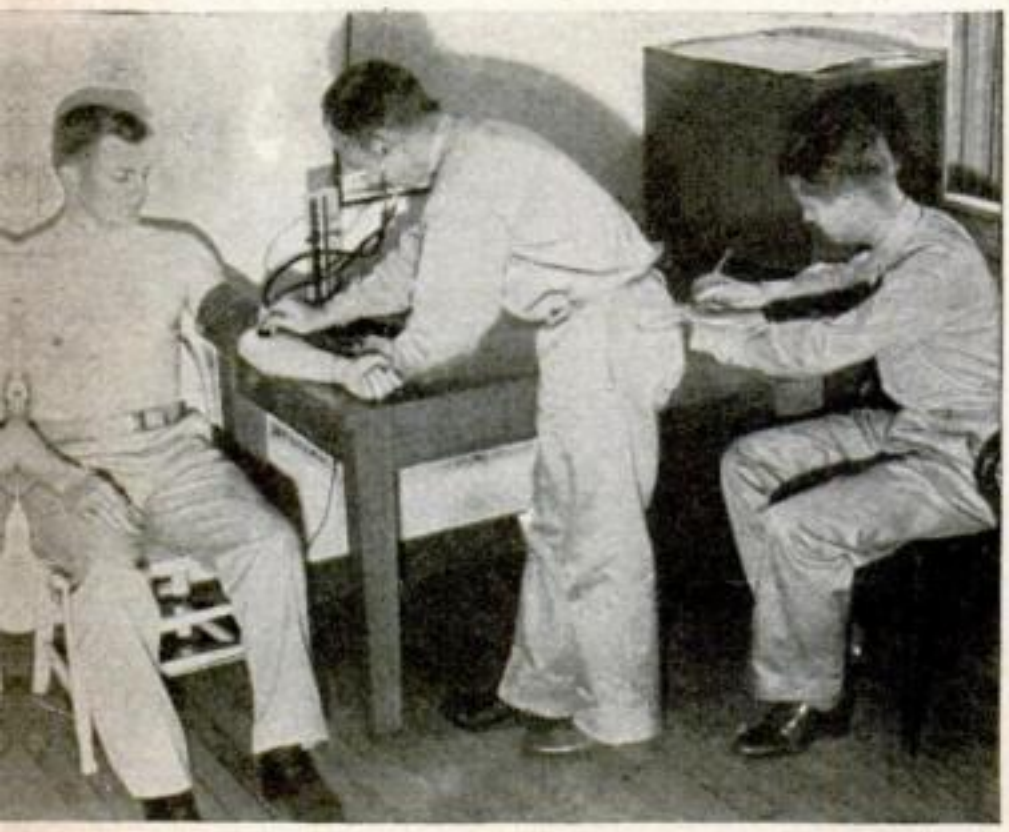
Climbing into the cockpit, he carries the scratch pad that clips onto his right knee for making notes on instrument readings and other data. This time he is putting a North American O-47 through the test

Now he is all set for the take-off—scratch pad on knee, earphones plugged in. Flying all kinds of planes, with different arrangements of controls, requires careful study (CONTINUED)

Finishing his test, Lieutenant Cooper fills out his report and turns it in to the engineer. Such a report on a new military plane serves as guide for the use of that plane in tactical operations



Sometimes, to get a double check on a doubtful point of plane performance, Cooper may turn a ship over to another pilot for a further test. Discrepancies in the various test data must be thoroughly ironed out

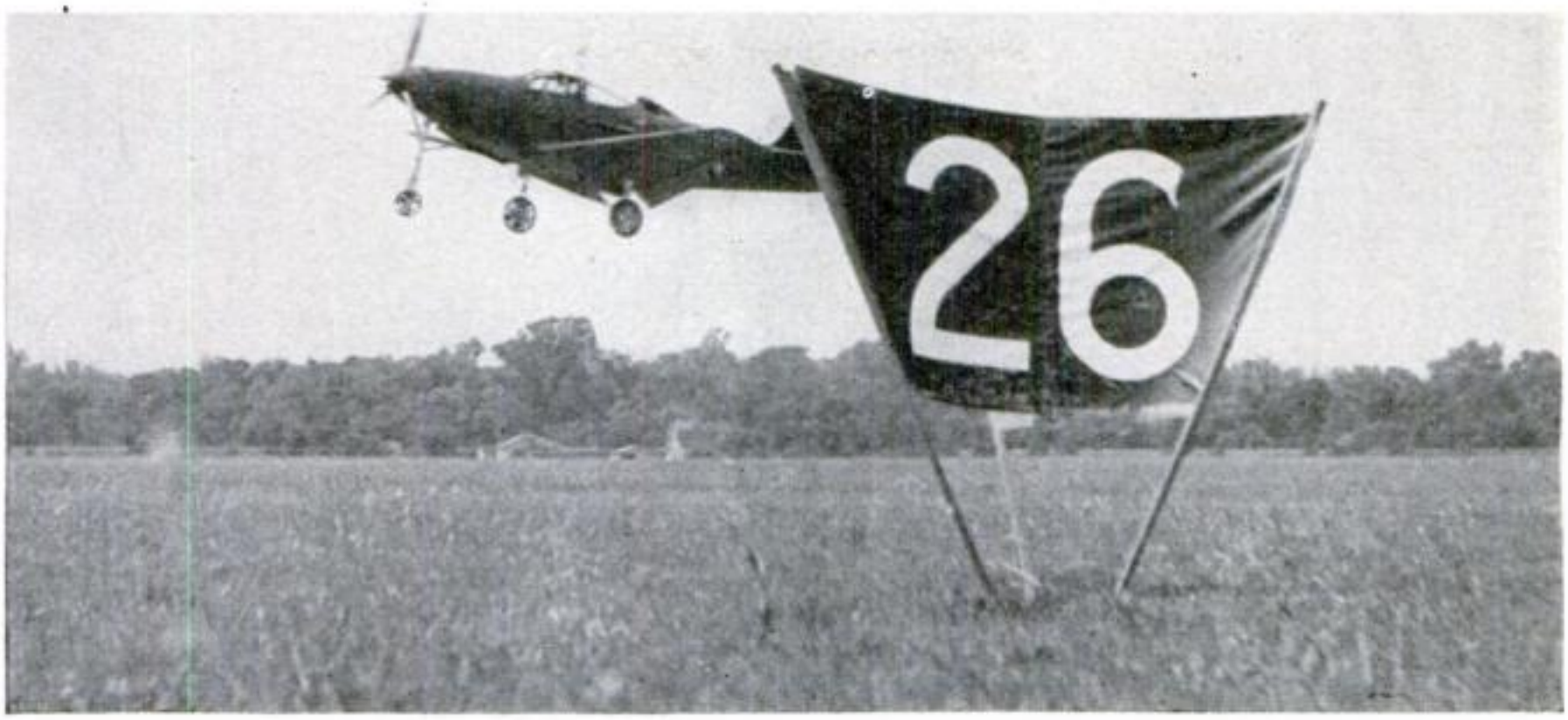


Seventy-five hours of flight-testing in a month calls for physical fitness of a high order. Here Cooper gets a Schneider test for blood pressure as part of the required semiannual health exam

Off duty, he is greeted at home by his wife and 2½-year-old son, Mickey. Thirty-two years old, Lieutenant Cooper has been married 5½ years. He studied aeronautical engineering two years at Georgia Tech

After cadet training at Randolph Field, he went into commercial flying. Returning to the Army, he served with bombardment and pursuit groups. Below, he relaxes in a quiet evening at home

. . . . and his favorite hobby of photography. The Army test pilots don't look on their work as specially romantic or dangerous. They say that practically all of the perils have been engineered out of their job



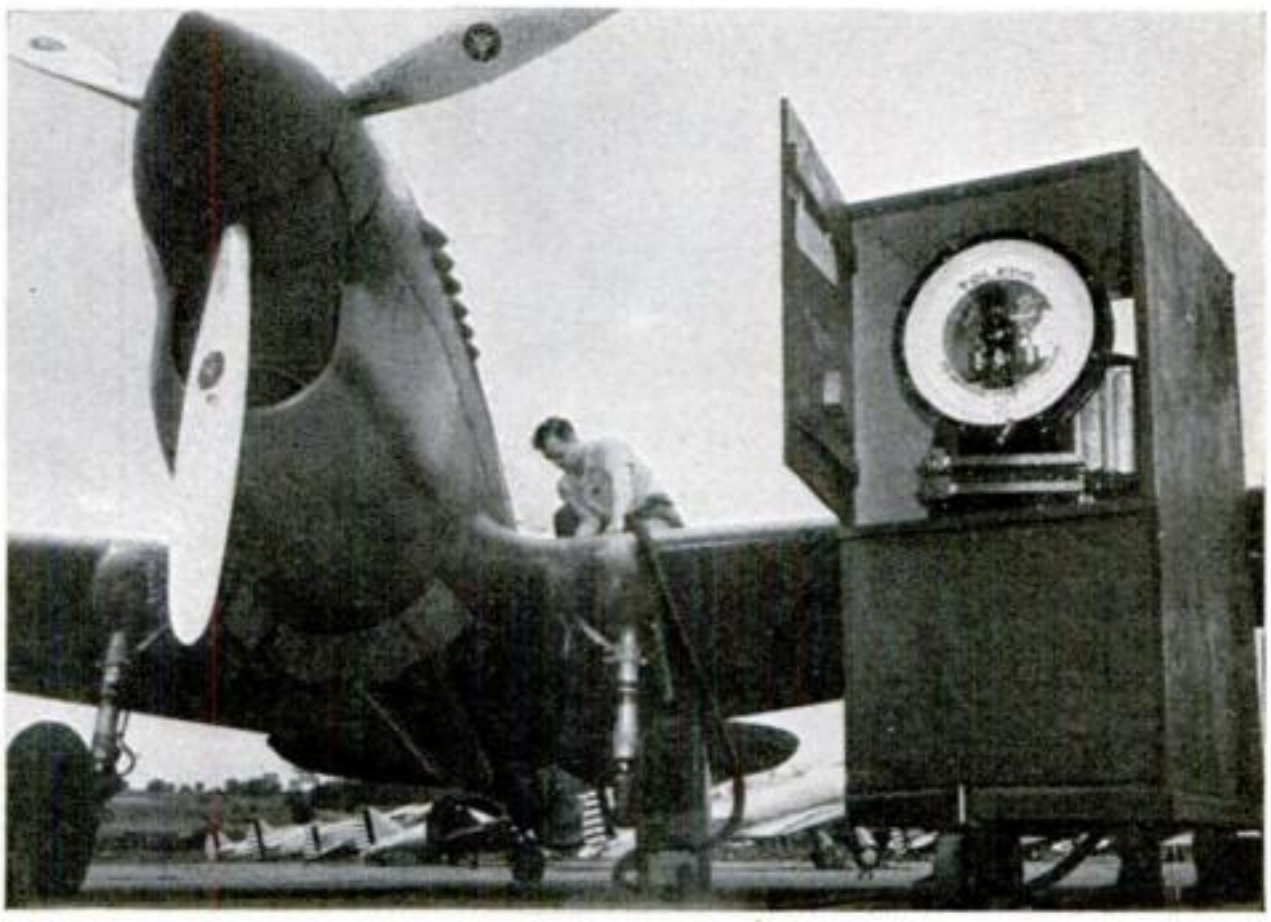
Take-off and landing characteristics of new planes are studied on a measured course, with cameras and optical instruments set up to show exactly when the ship clears an imaginary obstruction of given height

to fly every one of them, so well, up to its maximum performance, that his report may serve as the standard for the use of that plane in tactical operations. If a tactical pilot is confidentially informed, for instance, that his new bomber has been taken off in 1,500 feet over a 50-foot obstacle, he knows that he has to have a field of at least 2,000 feet to get that plane in and out with any degree of safety and comfort.

The test pilot's day may start with a flight in a Flying Fortress, followed by a turn around the field in a tiny primary trainer, and topped off with some acrobatics in the latest model of P-40. The bulk of his work consists of taking a new plane model and putting it through an elaborate standardized routine of tests, but he also has to observe and comment on that plane's handling qualities. To do that he must keep himself attuned, by flying a great variety of ships, to all the finest differences of control.

Hands are as important to a test flyer as to a surgeon. That was indicated by Lieut. Col. Stanley M. Umstead, chief of the Army's test pilots, when he took up the giant new bomber, XB-19, for its maiden flight. Engineers, not certain that mere manpower could handle the 82-ton ship dependably, installed a system of hydraulic controls. But one of the first things Umstead did when he got in the air was to cut out that system. He wanted to fly by hand.

There are ordinarily about a dozen officers in the Flying Branch of the Materiel Division, under Lieutenant Colonel Umstead; but half of them usually are engaged in administrative work. On the other half



Loading a P-40 for a fuel-consumption test. Gasoline is weighed and measured carefully for an accurate check on flight duration. So exact is this test that it cannot be given on an extremely hot day, when evaporation is considerable

Ready for a high-altitude test. With service ceilings for warplanes rising to 30,000 and 35,000 feet, more and more of the pilot's work is in the substratosphere. The flyer at left is wearing an improved oxygen mask. At right, a pilot conditions himself by breathing oxygen in a decompression chamber

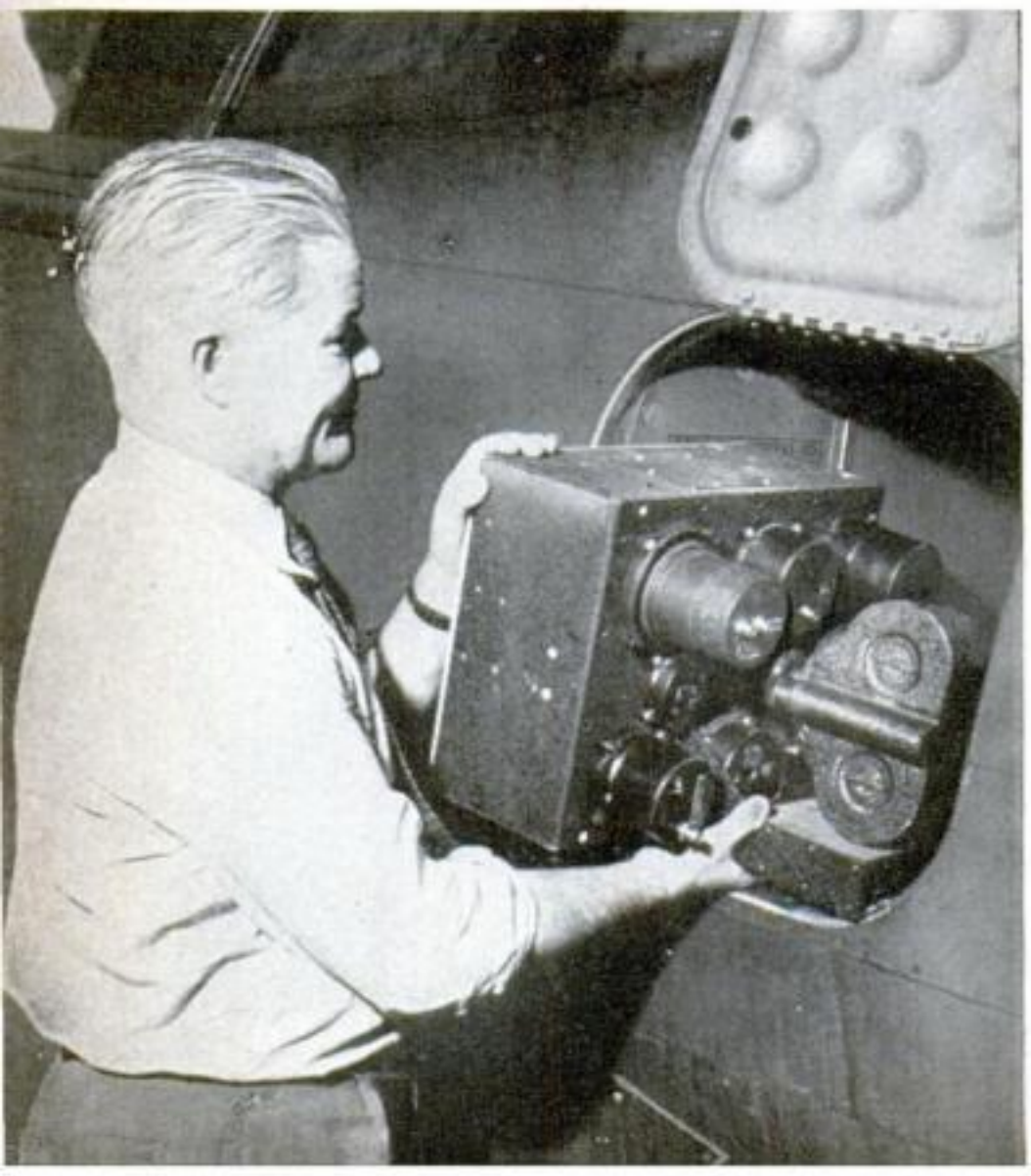
dozen falls the brunt of giving workouts to the new models of military planes which are pouring from American factories in an increasing stream.

The test pilot pays dearly for his fun, in terms of a rigorous self-discipline which is almost beyond the comprehension of most of us. A veteran flyer, selected for his skill, he has to practice intensely for nearly three months with planes of known performance, before he is ready to start actual testing. In less time than that, the greenest dodo can learn to fly an airplane reasonably well.

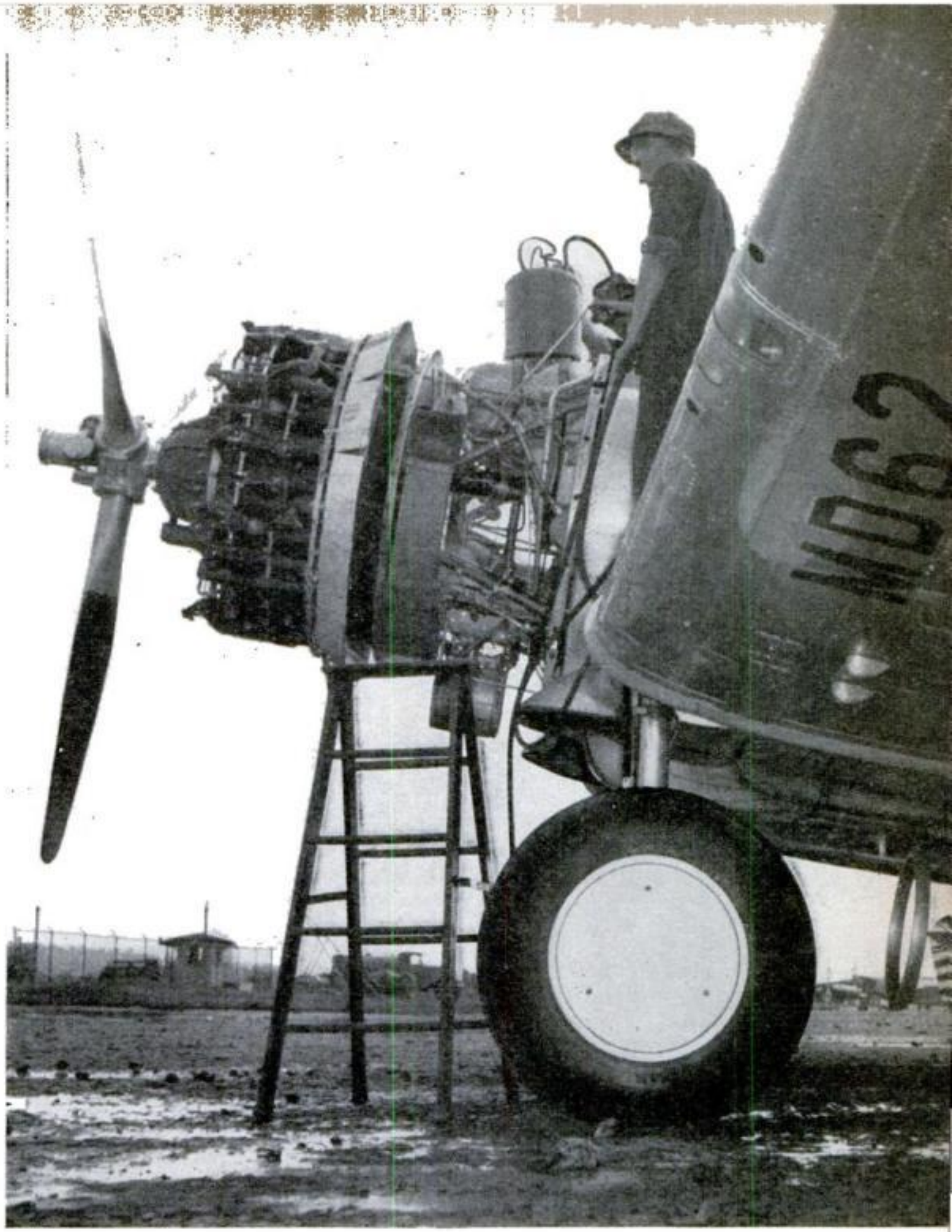
In the course of a year, the test pilot spends between 500 and 600 hours in the air, which is about twice as much flying as is done by the average Army pilot. But that doesn't tell the story. In most flying, a man can relax and take it easy after he is once in the air. But the test pilot must concentrate every instant on his instruments. About 75 hours of that in a month just about touches the limit of human endurance.

To most of us the term "test pilot" is synonymous with danger, but the flyers themselves say that most of the dangers have been engineered out of their job. Also, the most dangerous test—the dive—is performed at the factory before the Army accepts delivery of a new plane. A pursuit plane, for instance, must be able to dive at 160 percent of its rated level speed. That is, a 400-mile-an-hour plane must dive at 640 miles an hour, and the manufacturer hires a test pilot, for $10,000 or so, to risk his life in proving the plane can do it. Once this feat has been recorded by instruments, there is no need of repeating it. There rarely is occasion for an Army man to do one of these power dives.

There is danger of mechanical failure, of course, whenever new and untried equipment is used. The test pilots admit there is one especially breathless moment when they are performing their landing and take-off tests. When a plane is pulled off the ground, at full power and maximum climb, its nose is right up in the air; and a power failure at that instant would leave the pilot helpless. Power failures do occur in new planes. For no matter how thoroughly an engine



Into the baggage compartment of a single-seater plane goes a photographic observer, a device that helps the busy pilot by making a film record of the readings on a duplicate set of plane instruments



No matter how well an engine has been tried out on the ground, its installation in a novel type of plane has something untried about it. The test pilot reports any irregularities in its performance, and these are corrected by mechanics before it is used again. Here a mechanic is making some adjustments

has been tested, its installation in a new model always has something untried about it.

The Army flyers admit they are pretty good at these landing and take-off tests. One of them went to a factory not long ago to start work on a new ship, it is related, and found the private test flyers there in a state of embarrassment. They had not been able to get the ship off the ground within several hundred feet of the required distance. The Army pilot took a few trial spins and then pulled the plane up in 500 feet *less* than was specified in the contract. Privately employed flyers are likely to be gentle with their employers' property, but the Army test men push the new ships right to the limit. It is customary nowadays to burn up two sets of brakes in the course of a series of landing tests.

Modern high wing loadings make landing and take-off a very fast matter. The tests are made along a measured course, with cameras and optical instruments set up to record the point at which the plane clears an imaginary 50-foot obstacle. Results are obtained which sometimes leave experts skeptical, unless they have actually seen the tests. The new tricycle landing gear, with the small wheel in front and the paired wheels behind the center of gravity, makes it possible, for instance, to come in at cruising speed and jam the brakes on full as soon as the wheels are on the ground. In actual service such feats would wear planes out in very short order, but in a military emergency the incredible often becomes necessary.

Army test pilots are inclined to talk, not about the thrills or *(Continued on page 220)*

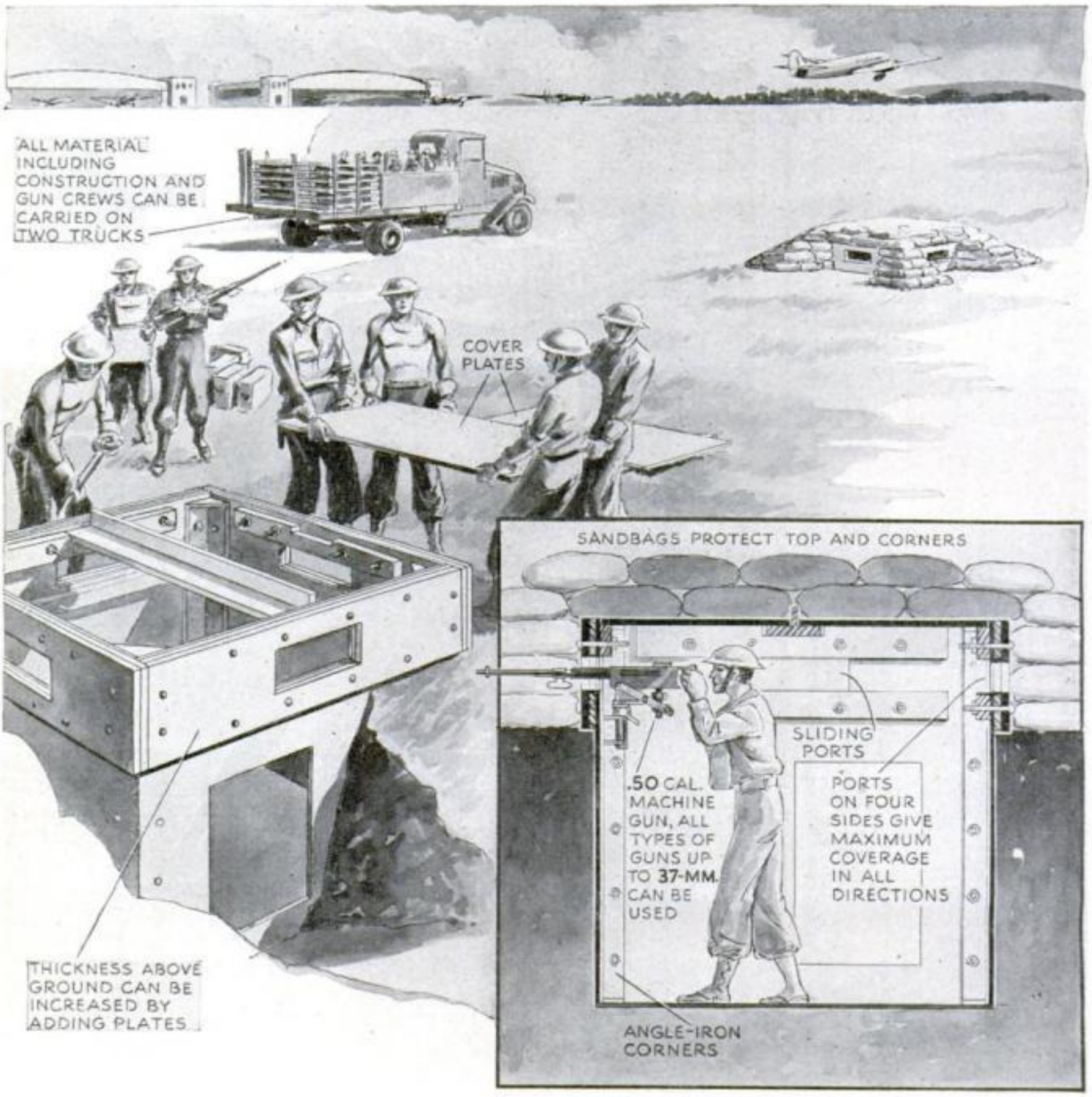
STEEL PILLBOX IS ASSEMBLED IN 1½ HOURS

A PORTABLE steel pillbox six feet square has recently been developed for the Army by Lt. Col. R. B. Lord. It consists of 14 basic plates that may be bolted together on location in one and one half hours after the hole has been dug to place it in.

The new pillbox stands 20 inches above the ground and has sliding ports on all four sides which give a 360-degree field of fire for 37-mm. guns or machine guns.

The armored sides give complete protection against all projectiles up to and including the 75-mm. high-explosive, and tanks can run over the top without damaging it. The gunner inside the pillbox can shoot the belly out of any tank that attempts to cross it.

In recent experiments, two chickens were shelled for three weeks inside the pillbox. Aside from being slightly shell-shocked, they went through the ordeal with no injuries. Chickens were chosen for the test because, of all animals, they are said to be closest to man in their reaction to concussion.



Artist's conception of the portable steel pillbox in use and being assembled. Rising only 20 inches above ground level, it affords a 360-degree field of fire for its guns

The METAL THAT NEVER TIRES

BERYLLIUM FINDS WIDE USE IN THE AUTOMATIC CONTROLS THAT RUN MODERN MACHINERY

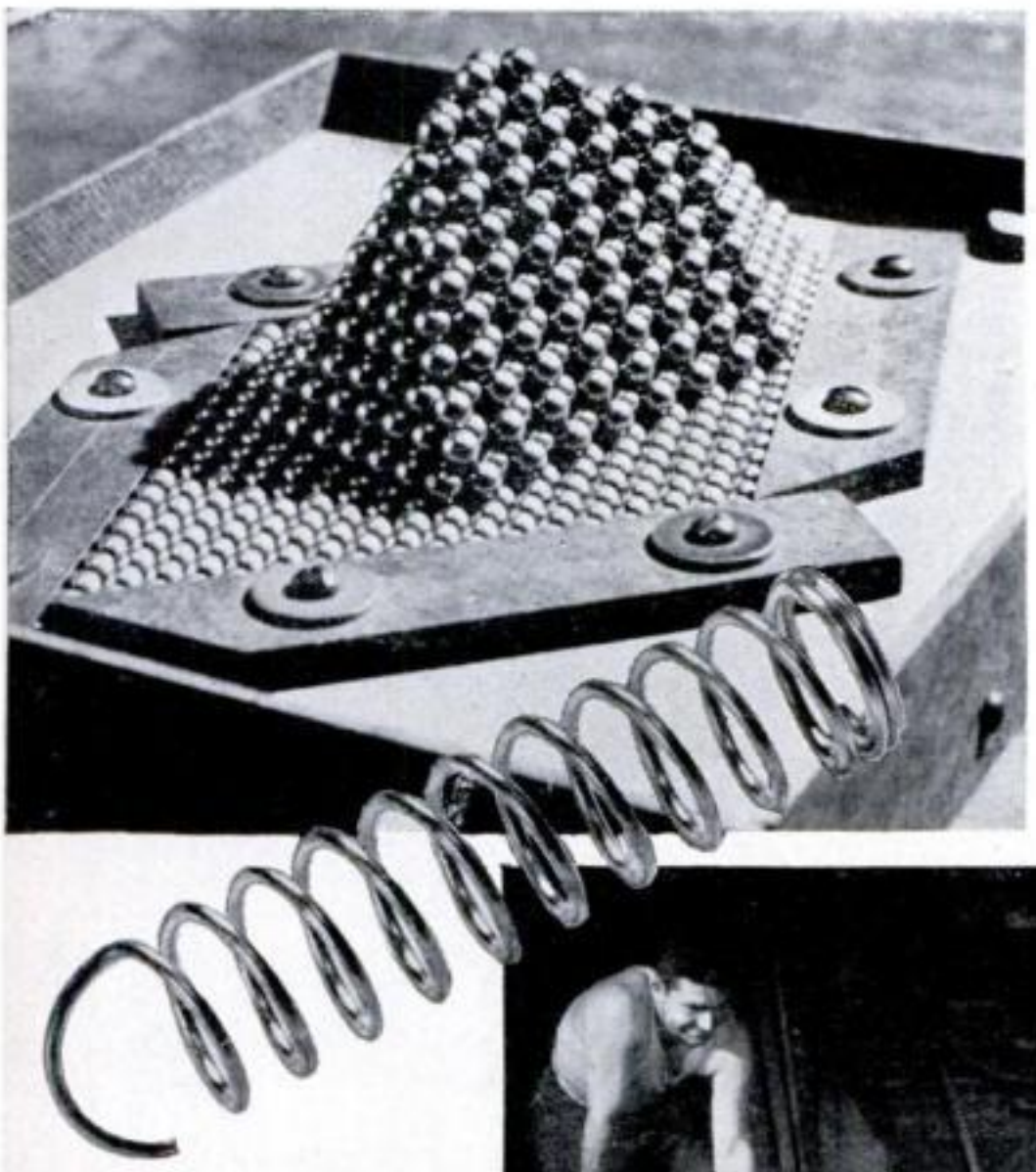
BY ALFRED H. SINKS

CHANCES are that you have never seen any beryllium, yet you probably have some occasion to use it every day. You take the jobs it does for granted, but they make a big difference in your comfort, safety, and pocketbook.

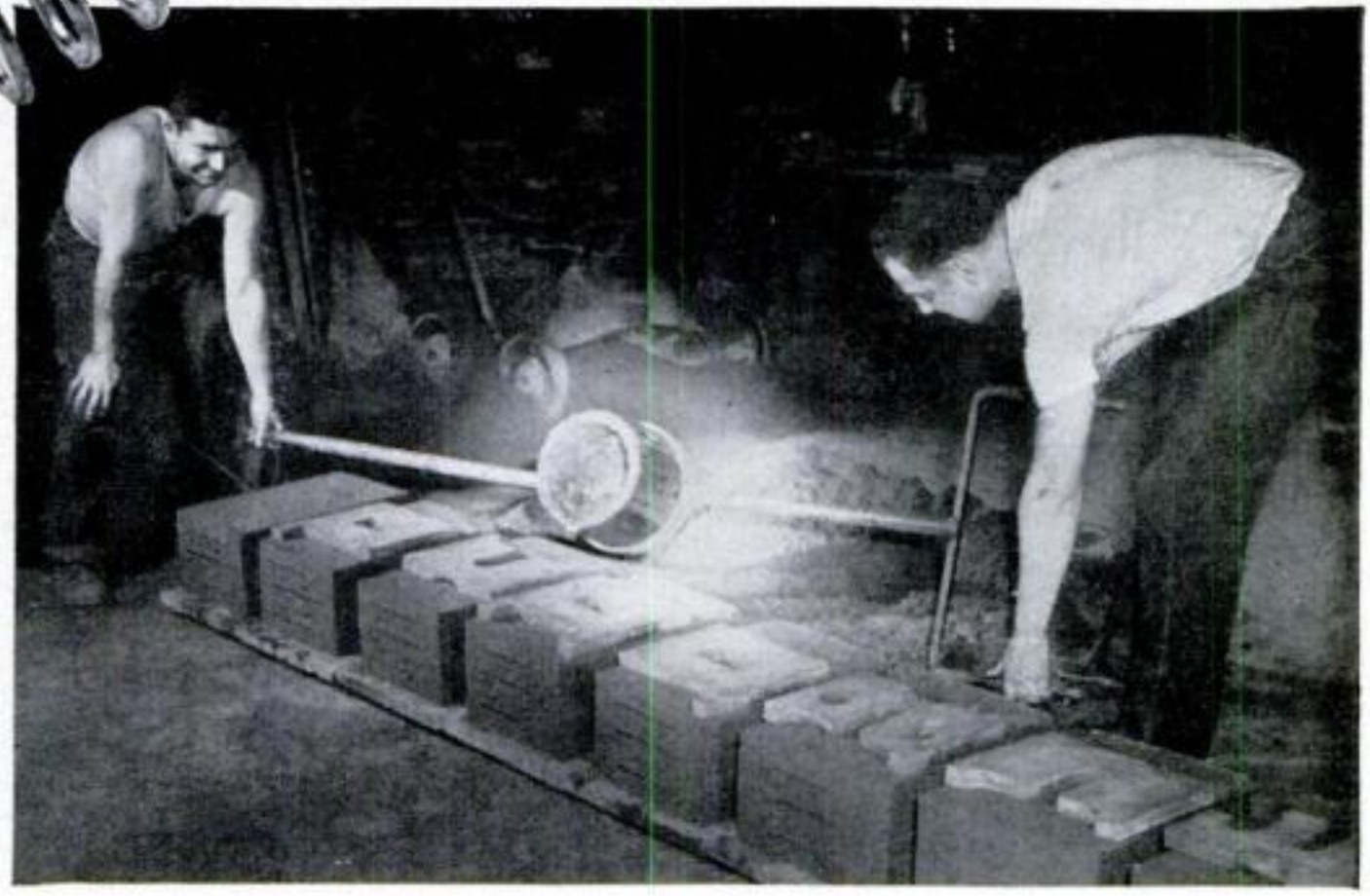
Because of beryllium your new vacuum cleaner will last four to five times as long as the old one. The same is true of your mechanical refrigerator and the thermostat control on your furnace. To get that picture of Junior mid-air in the pole vault you had to use a shutter speed of one thousandth of a second; you can rely on such precision because of a tiny beryllium-copper spring in your camera.

We think of the properties of a metal as being eternal. But all metals, under strain, get tired. The mainspring of your watch gets tired, for example, and the watch loses time. In industry, metal fatigue is a serious problem. When some single part fails, the wheels of an entire factory may be stopped. Today machines of all kinds must travel at higher and higher speeds. This makes it urgent that we have at every vital point in industry some metal—particularly for springs and intricate parts—that will hold up under increasing stresses. Beryllium-copper, for all practical purposes, is tireless.

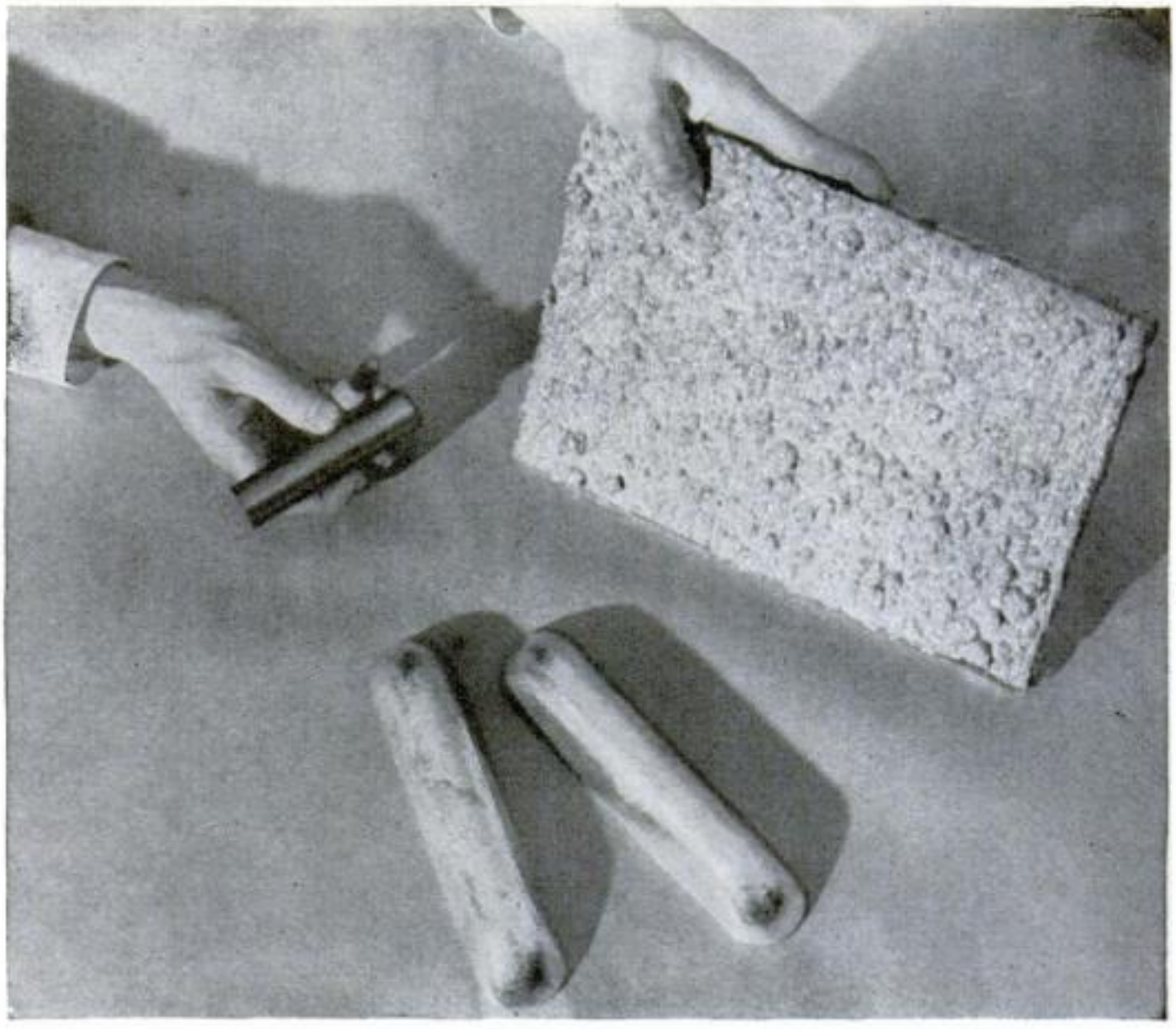
The endurance of any metal can be tested by an ingenious machine which



Ball bearings represent atoms in the model of a crystal of beryllium at the left. The close-packed, hexagonal structure explains tirelessness of beryllium-copper springs



Workmen at right are pouring castings of beryllium-copper. The "master alloy," containing four percent of beryllium, has a beautiful pinkish-gold color. For commercial use, this alloy is diluted with copper until the beryllium content is about two percent



Ingredients of beryllium-copper; one hand holds a stick of beryllium metal and the other a sheet of copper. In the foreground is the product, two five-pound "pigs" of the master alloy. In actual practice, the oxide of beryllium is used, the pure metal appearing only inside the alloying furnace

in effect depresses the piece and lets it spring back to its original position. The number of times it will spring back without breaking indicates its resistance to fatigue. Spring steel will stand 3,000,000 vibrations, under salt spray. Beryllium-copper will take *at least a billion* before it breaks.

That is why virtually all new aviation instruments have beryllium-copper in them —to give them permanent accuracy under the toughest possible conditions. The new altimeters depend on an activating beryllium-copper diaphragm, as tireless as it is sensitive to the slightest change in atmospheric pressure.

Modern aviation cannot get along without beryllium. Consider the Sperry robot pilot. The robot detects each variation up or down, right or left, in the direction of the plane's flight. It transmits its impulses to the controls that actuate rudder, ailerons, and elevators much as your nerves transmit impulses to your muscles. It corrects the plane's course more quickly than a human brain could react. And, unlike a human brain, it never loses efficiency through fatigue.

The robot pilot is built around two spinning gyroscopes, each turning over thousands of times per minute. Each of the bearings on which they turn is gripped by four springs, spaced like the spokes of a wheel. If one of those springs got tired, if it lessened its tension by so much as one two-thousandth of an inch, the rotor which it holds in place would stop dead. The instant that happened, the pilot would have to take over the controls and fly his 350-mile-an-hour bomber by hand. But today the pilot no more worries about that than you do about what's inside the gadget that keeps your refrigerator at a set temperature. The springs of the gyroscopes—in common with over 100 parts of the modern transport and bomber—are made of beryllium-copper.

HOW BERYLLIUM IS EXTRACTED AND ALLOYED TO FORM A WONDER METAL

Sacks of South American beryl ore (1) ride an electric truck to a crusher (2) where the hard rock, seen in the pile in the foreground, is reduced to a white powder. Treated with chemicals, this powder is pressed into "mud pies" (3) in briquette-shaped molds. Further treatment of the briquettes (4) finally extracts the beryllium oxide, a product resembling talcum powder. In the meanwhile, mammoth jaws (5) are chopping up slabs of copper to be combined with beryllium. The copper is placed in an alloying furnace with beryllium oxide and coke; as the coke reduces the beryllium oxide, the pure beryllium joins with the copper to form beryllium-copper, which comes out of the furnace (6) ready for casting as illustrated in the photograph on the preceding page


1


2


3


4


5


6

Instruments and gauges of all kinds, in hospitals, laboratories, factories, electric power plants, and on ships at sea make use of springs and diaphragms similar to those in aviation instruments. One mechanical bookkeeper used in many large business houses has 15,000 small springs—all made of beryllium-copper. The metal is beginning to be used in automobile manufacture, radio, electric motors—whenever there are higher speeds or exceptional strains.

Yet this metal baffled metallurgists for a whole generation.

Twenty years ago, two groups of metallurgists began experimenting with beryllium. In 1921 Charles F. Brush, son of the man who invented the electric arc lamp, opened a laboratory in Cleveland with C. Baldwin Sawyer, just back from Massachusetts Institute of Technology bearing a brand-new doctor's degree. Maurice D. Sarbey and Hugh S. Cooper, both employed by the Union Carbide & Carbon Company, also began working with beryllium.

Beryllium had been discovered as a chemical element in 1797. Now it was noised about that beryllium was more than a footnote in high-school texts. It was something you could see and feel—a metal one-third lighter than aluminum, yet harder than steel.

The country, just crawling painfully out of a depression, was ripe for miracle stories. Cleveland's newspaper row heard about beryllium. Reporters rushed out to Cooper's laboratory to witness the new miracle. Typewriters began to make frantic ballyhoo. In a machine age such an unheard-of combination of lightness and hardness suggested boundless possibilities. The new wonder metal was expected to set the wheels of factories humming on a new industrial age.

But things don't happen fast in metallurgy. Beryllium proved temperamental. True, it was both amazingly light and hard. But in spite of its hardness under steady pressure, it was brittle under an impact. It would shatter like glass when dropped.

Metallurgists, fearing that a metal so brittle would never be of much use by itself, tried combining it with other light metals—aluminum, for instance. But beryllium was finicky. With aluminum it made a fragile alloy that could not even be rolled without breaking.

Miraculous results seemed always just beyond the grasp of men who struggled with beryllium's tricky properties. Then a young Tennessee Irishman, Andrew J. Gahagan, got stirred up over the metal. His interest had begun during his undergraduate days at Columbia University. Afterwards he worked his way through the Ford Motor Company, acquiring on the assembly line and later on the side of management a first-hand knowledge of modern industry. His imagination was touched by everything he heard about beryllium.

Like a Paul Bunyan he crashed through the forests of finance, and with some of the resilience and tirelessness of the metal he was to develop, he spread everywhere the story of beryllium's future. Confidently Gahagan bought up existing patents and began sending engineers throughout the country to examine deposits of beryllium ore. To carry on the necessary experimental work he engaged as chief metallurgist J. Kent Smith, who as a young man had worked with Madame Curie.

In a small laboratory at Detroit, Smith and Gahagan carried on their experiments through a long series of baffling failures. Each new alloy developed kinks and quirks all its own. But the two enthusiasts pushed right on. They tried combining beryllium in various proportions with almost everything they could think of. After about two years of work, they made a startling discovery. When a small amount of beryllium (two percent) had been added to copper, copper could be hardened by heat treatment as steel is hardened.

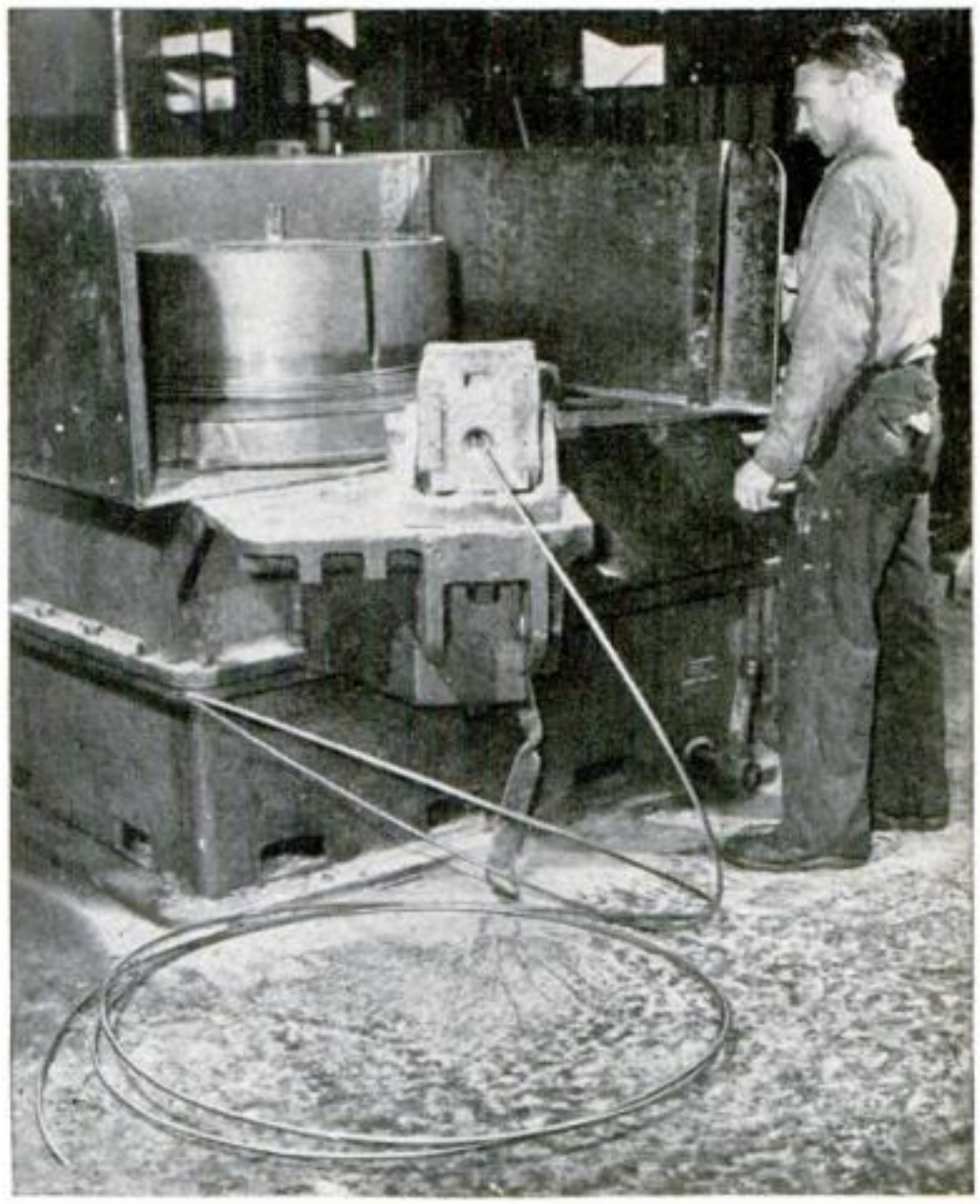
In the laboratory of a copper company they hoped to interest in their discovery, Gahagan and Smith watched their alloy tested for tensile strength. The needle on the indicator of the testing machine climbed higher and higher. It passed the normal figure for brass, for bronze, for stainless steel, for almost every known material. It did not snap until the needle rose to show a tensile strength of 185,000 pounds per square inch! In everyday language, the story told by that machine was this: a rod half an inch in diameter, if made of beryllium-copper, would lift a weight of 20 tons!

Next they tested the hardness of their new alloy by setting a disk of beryllium-copper on top of a larger piece of cold-die steel. This copper had two percent of beryllium in it. They placed the copper and the steel between the jaws of a giant hydraulic press. Under 400 tons pressure, not the copper but the *steel* gave way. The copper disk, absolutely unharmed, was embedded in the softer steel!

Beryllium had graduated from the laboratory at last. There would be plenty of jobs for a metal that would do what no other material could do. Cornelius Vanderbilt Whitney became interested, putting up the first part of what was to be a $545,000 investment.

Gahagan began refining beryllium from ore and producing beryllium-copper. At first he sold his product through copper companies. Later, as business increased

This powerful machine draws a beryllium-copper rod through a tungsten-carbide die to reduce its diameter. By repeating the process, it turns the rod into fine wire



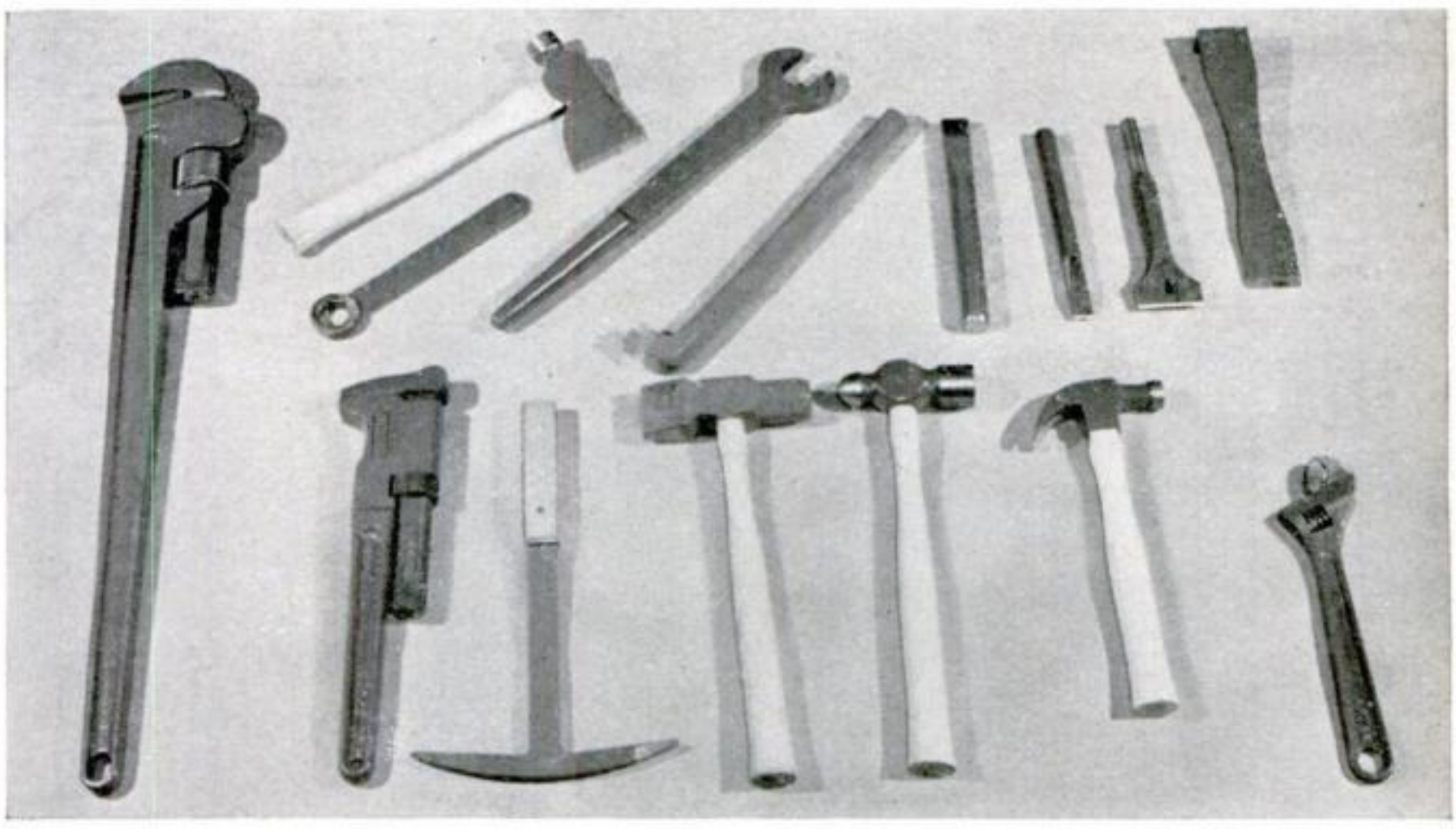
and the copper companies became jealous of the new alloy, he moved the Beryllium Corporation plant from Detroit to Reading, Pa., and began making beryllium-copper for aviation companies and other customers and turning out finished tools of his own. He added the German patents to those he had already acquired and, just before the present war broke out, brought from Germany valuable machines to aid in fabricating the alloy. He has also devised a good many methods of his own; one operation which still takes the Germans 17 hours can be done at Reading in two.

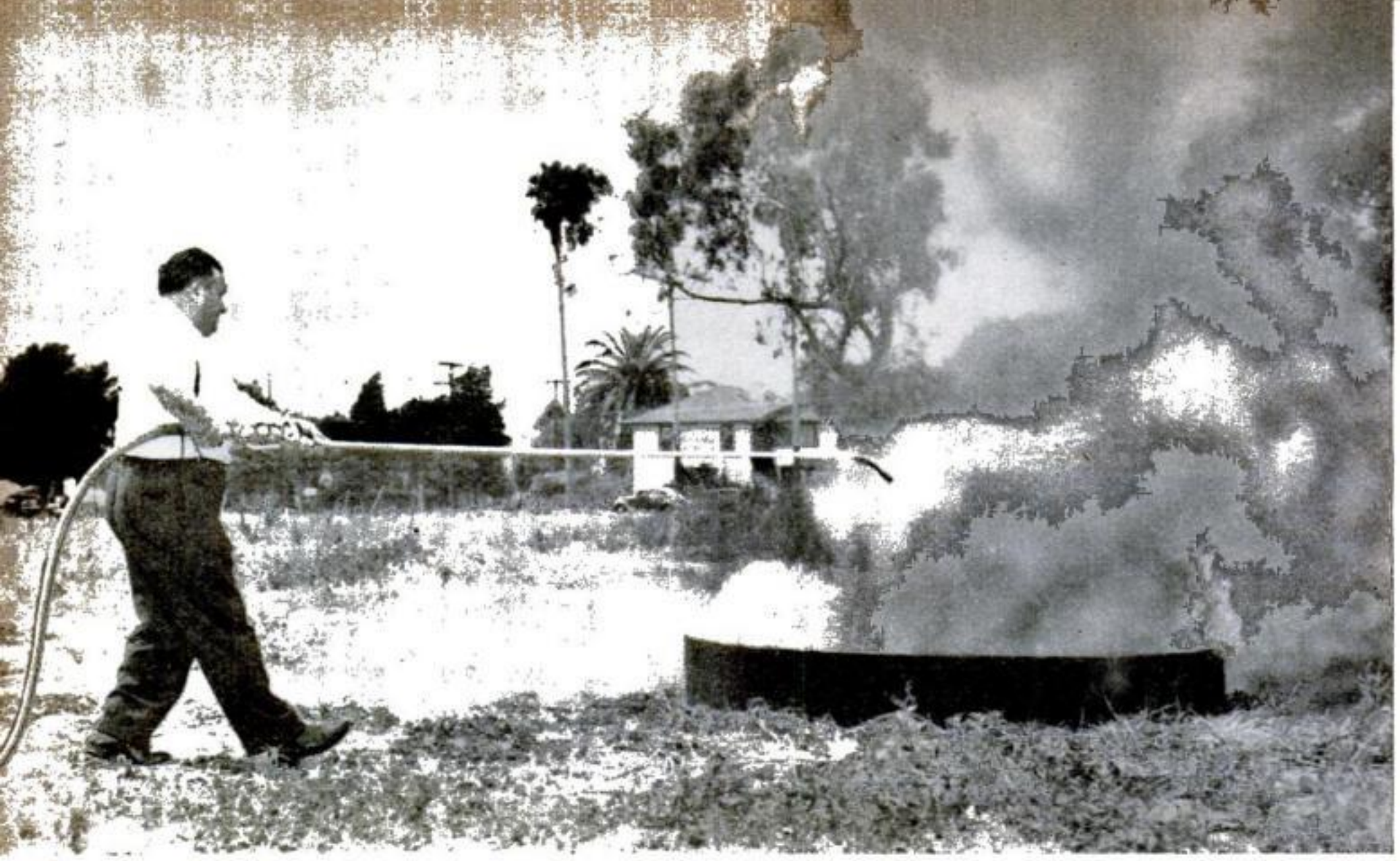
Time and experiment revealed that beryllium-copper had other useful qualities besides its strength. In oil refineries, grain elevators, and munitions plants, where iron tools rasping against a steel shaft might strike a spark and cause a fatal explosion, workers use hammers, chisels, shovels, and hand tools of beryllium-copper.

In scores of odd places it is important that the metals used be nonmagnetic. Steel buckles on parachute harness often set a plane's magnetic compass askew, so they are now using beryllium-copper buckles instead. Equally in machines that must work in a damp atmosphere, or near salt or other corrosive chemicals, beryllium-copper is useful because it will not rust or corrode.

Nothing else will take so much all-around punishment. As *(Continued on page 224)*

Because they don't strike sparks, tools of beryllium-copper can be used in powder mills, oil refineries, and other places where there is danger of explosion. This alloy is hardened like steel by heat treatment





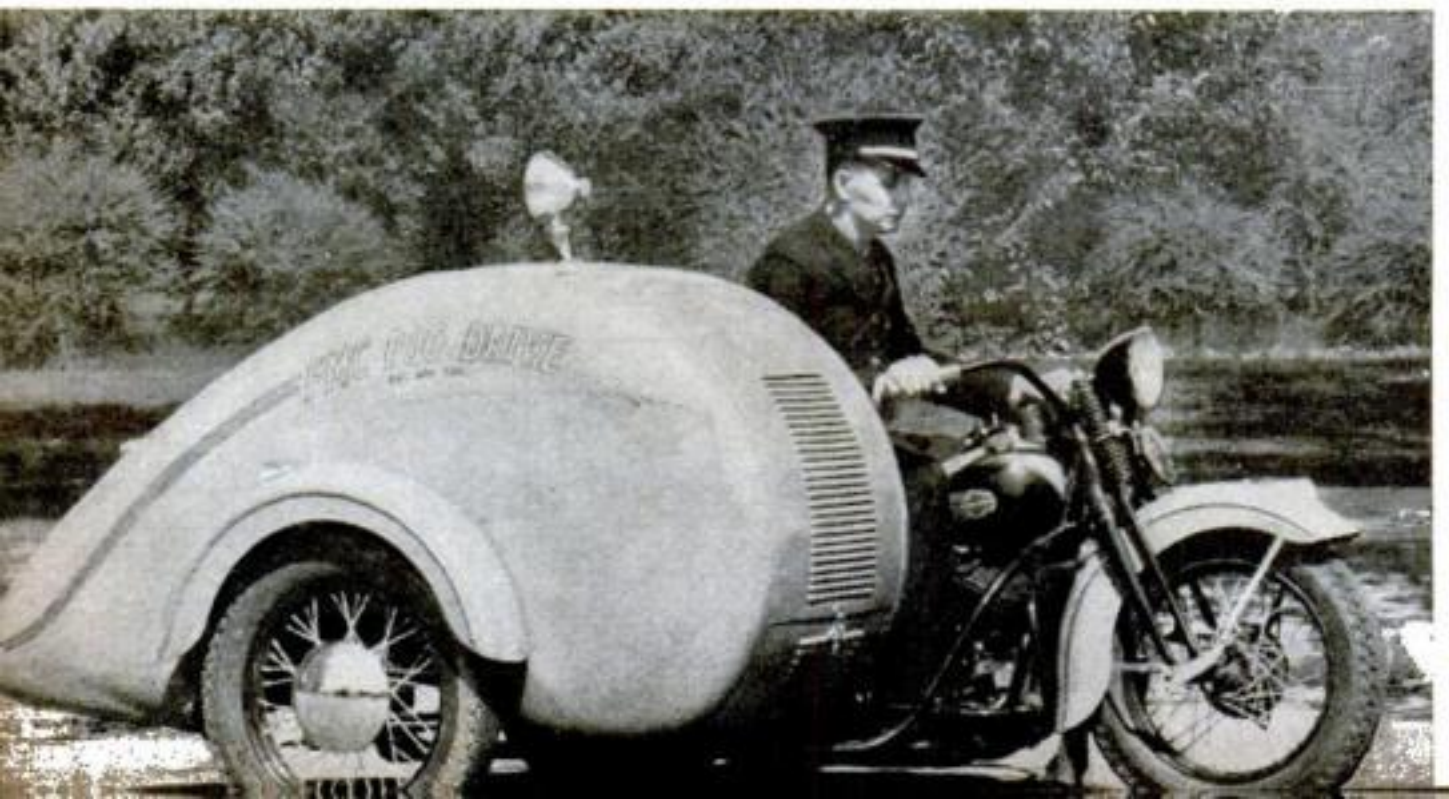
Putting out a test fire with a fog-producing spray which smothers the flames under droplets of water

War Teaches Us To Fight Fires

Methods and Equipment Born of the Emergency Have Permanent Value

A LENGTH of garden hose, with a spray nozzle on one end and a stirrup pump on the other, has become one of England's chief defense weapons. And out of this and more complex devices, designed for protection against fire from the sky, has grown in the United States a vast civilian army of trained fire fighters, with new equipment never dreamed of until the war emergency forced invention upon us. Whether incendiary bombs ever drop on this country or not, the lessons it is learning are all to the good, for fire, come peace or war, is a major hazard of civilization.

A bucket of water and a stirrup pump, with a nozzle producing a fine spray, is the simplest of the fire-bomb defense apparatus derived from the lessons learned in the great London fire raids of 1940. Thousands of such pumps and pails now are being made and distributed in this



A pumping unit mounted on a motorcycle side car, one of many mobile outfits developed in America as improvements on the water bucket and hand pump that saved London in 1940. It can thread its way easily through streets that are filled with debris

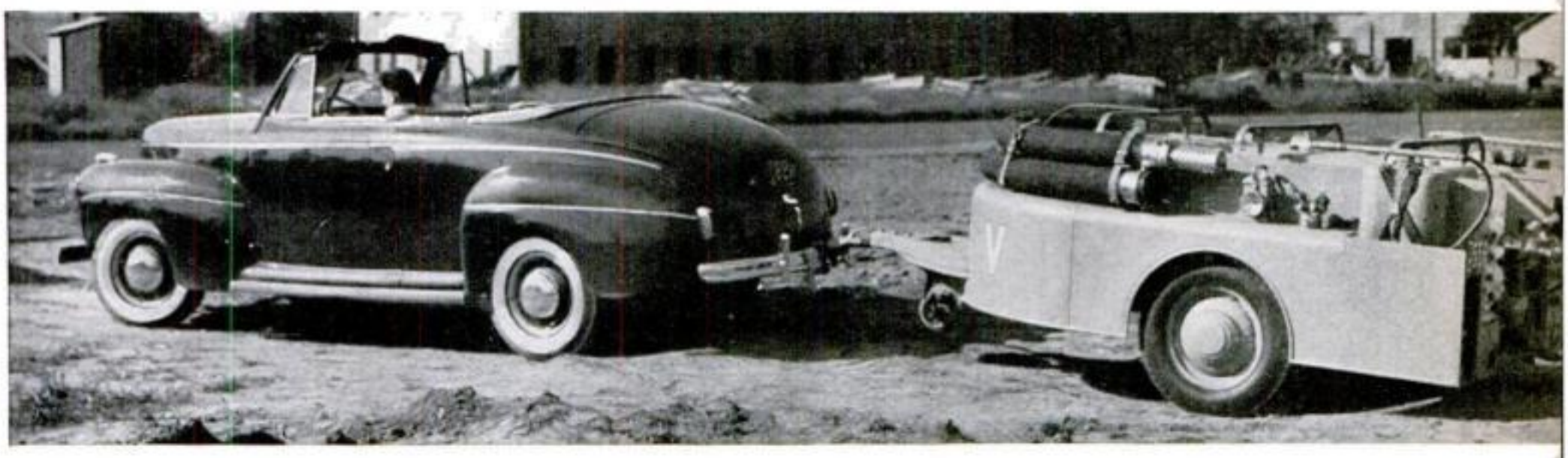
country. They are effective enough where fires caused by incendiary bombs or the bombs themselves can be got at quickly and easily, but their limitations are obvious.

Here ingenuity and inventiveness have stepped in. The foremost contribution to fire fighting is the development of small, compact, low-slung trailer pump units which can be towed swiftly to the scene of an emergency by an automobile. Weighing from 1,600 to 3,000 pounds, each trailer carries 500 feet of 1½-inch hose, or 250 feet of 2½-inch hose, and is capable of pouring a 500-gallon-a-minute stream of water into a burning building. Pump pressures range from 100 to 250 pounds. One of the newest of these trailers develops 250 pounds pressure with its gasoline engine running no faster than the motor of a truck rolling along a level road at 40 miles an hour.

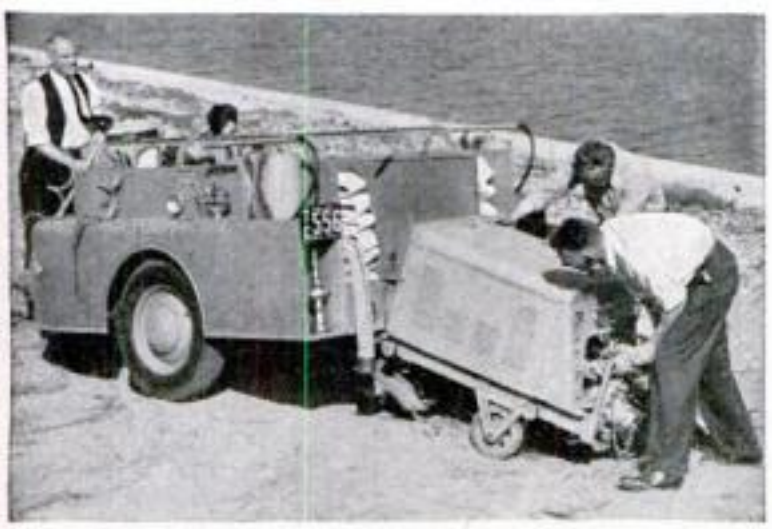
These units, because of their small size, can be maneuvered through streets filled with air-raid debris which would block conventional fire apparatus. One of the trailers has a pumping mechanism which is carried on a dolly and may be rolled from the trailer under piers and into other restricted quarters. Another manufacturer has produced a pumping unit which can be attached to a motorcycle, like a sidecar. Half a dozen American firms now are making such trailer units. Eight different types were tested successfully in New York City some months ago.

Another invention is a trailer pump that turns water into fog. A special atomizing nozzle, worked by a hand trigger, breaks high-pressure water into a mist so fine that it is estimated there are 43,000,000 particles produced from a single gallon. The water is delivered to the nozzle at a pressure of 600 pounds.

The reason for the emphasis on spray or mist in fighting incendiary bombs with water is the composition of the bombs. The most common type is the magnesium bomb, weighing from two to four pounds. As

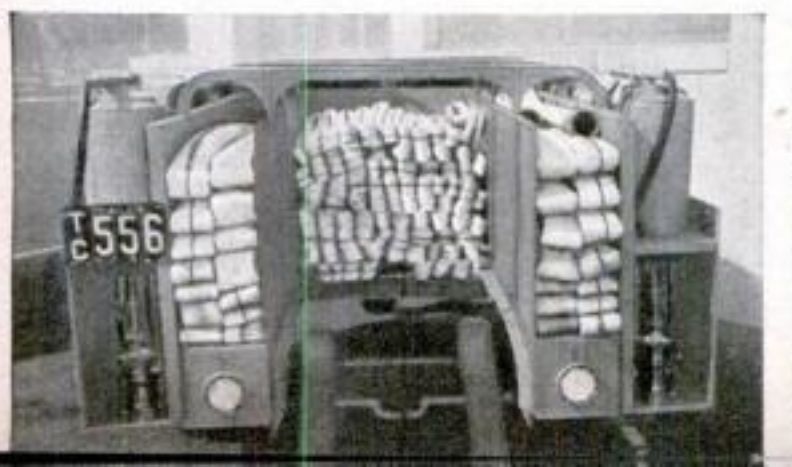


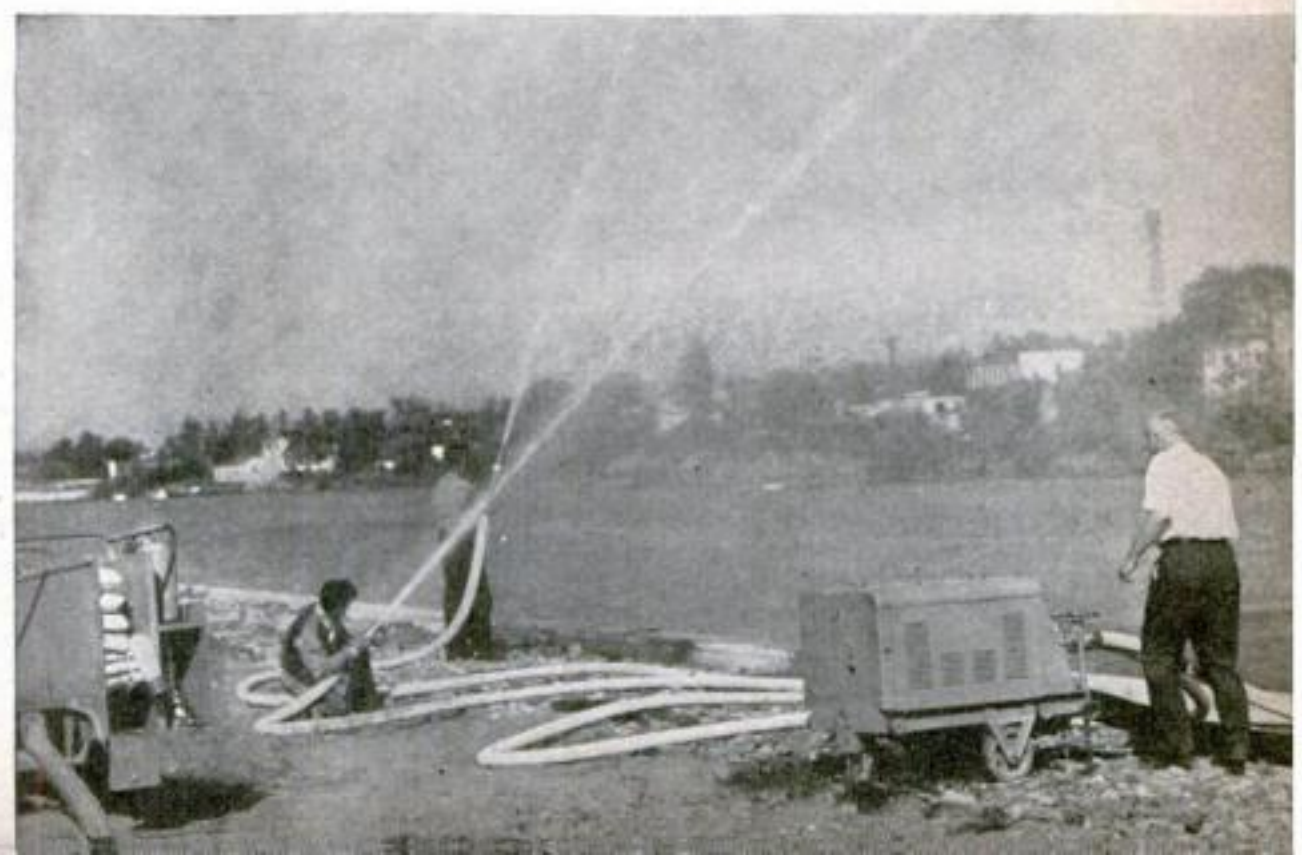
This is one of the new trailer pump units that can be towed at high speed to the scene of an emergency behind an automobile with 500 feet of 1½-inch hose or 250 feet of 2½-inch hose . . .



The motor unit rolls off the trailer on tracks seen below, and is pulled back with a hand-operated cable

. . . and can pour 500 gallons of water a minute into a burning building. Below, the dolly-mounted pump motor shows what it can do. The water may be drawn up from any convenient source





many as 2,000 may be dropped from a single plane.

These bombs consist of a magnesium shell loaded with a core of thermite. A detonating cap ignites the thermite, which burns only for a few seconds but with tremendous heat. The heat fires the magnesium, which may burn for 20 or 30 minutes and which causes the trouble.

Magnesium is a very active metal. Once afire, it will draw the oxygen it needs for combustion from almost any compound with which it comes in contact, including water. In fact, water is apt to make magnesium burn more fiercely. This has given rise to the belief that water is useless in extinguishing fire bombs. The truth is that a steady stream of water will cause the magnesium to splutter or explode, spreading the fire, but a spray will sometimes cool the magnesium enough to put out the fire and in any event will wet down the immediate area to keep the fire from spreading.

Thus the manufacturer of the fog-producing trailer pump asserts that flames which resist chemicals and streams of water have been choked off by vapor blankets. Another claimed advantage is that behind a fog blanket a fire fighter can approach closer to a fire, largely protected from its heat. The operator, by working the hand trigger on the nozzle, can change the density of the fog as he desires and if need be can turn the fog into a solid stream.

Two more American developments for fighting incendiaries have been reported. One is a secret powder produced by the joint research of two industrial laboratories. The powder has a base of graphite which is so inert it will not combine with burning magnesium. It also liberates a gas which forms a blanket around the magnesium and keeps the air away.

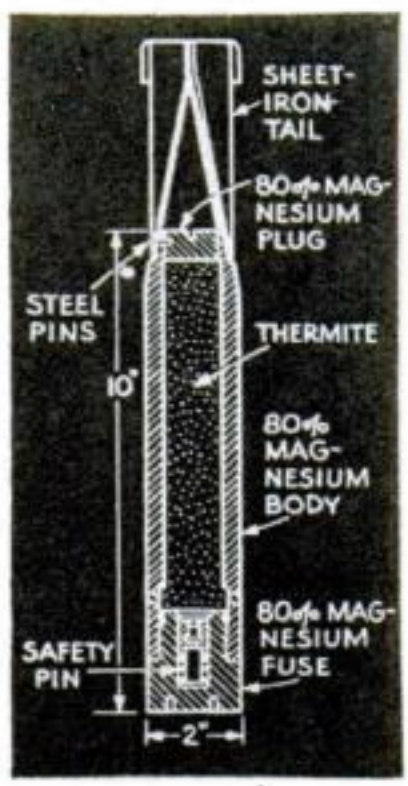
The second of these inventions is the work of Leonard Gibney, a young General Electric employee in Lynn, Mass. He developed in his spare time a pastelike mixture which can be poured over a burning bomb like frosting over a cake. In tests the mixture has put out flaming magnesium in less than a minute. He has submitted his formula to Government officials in Washington.

The traditional inventive talent of Americans has nowhere been better demonstrated than in the designing of new fire-fighting equipment. In Milton, Mass., four mobile units have been made at a cost of $400 from junk automobile chassis and other scrap parts by city employees. Starting with the front wheels and axle of a 1929 model automobile, the men constructed one unit equipped with 300 feet of 1½-inch hose, a 100-gallon booster tank, and a two-inch rotary pump run by a motorcycle engine. The other three machines made use of a discarded hose-truck body, a junked chassis, an abandoned lawn-mower motor, and similar castoff equipment.

Another weapon against incendiary bombs is sand. If used in time, a few shovelfuls of sand thrown over a bomb will smother it effectively. A refinement of this method is the so-called sand blanket, a bag partly filled with sand. The user advances toward the burning bomb, with this blanket held in front of him, and tosses it over the bomb.

The great new army of American volunteer fire fighters is being trained in all these new methods of fire fighting. In such widely separated communities as Waterbury, Conn., Memphis, Tenn., Beverly Hills, Calif., and Sarasota, Fla., groups are training for action. Americans are learning that proper training and equipment can conquer incendiary bombs. They are learning that fire from the sky is to be fought, not feared.

How to Put Out a Fire Bomb



This is a typical magnesium bomb, and its construction is shown in the drawing at the left. The magnesium shell is loaded with a core of thermite, which is set off by a detonating cap. Thermite ignites magnesium, which does the damage

Water may make magnesium burn faster, and should never be applied in the form of a solid stream, as this might cause an explosion. However, a coarse spray will often cool the magnesium enough to put it out. Anyway, it dampens the surrounding area, confines damage

Sand is an effective weapon against incendiary bombs. A few shovelfuls thrown on a bomb early in the game will smother it completely. Another way to use it is in the so-called sand blanket, a bag partly filled with sand. The user holds it in front of him for protection against the heat while advancing, as shown at the far right, then tosses it on the bomb

Jumbo never ran a race in his life, but he has earned more money than many a turf favorite. In eleven years at the Lederle Laboratories farm at Pearl River, N. Y., this 2,000-pound Belgian draft horse has produced $60,000 worth of serum — 1,350,000 cubic centimeters, or enough to save the lives of 2,600 sick children

Animal Magicians

A $60,000 Horse, and Rabbits on a Modern Laboratory Farm Help Produce Precious Serum That Saves Many Human Lives

SIX HUNDRED well-fed horses, on one New York farm, watch tractors do all the work. Their business is not plowing or pulling wagons. It is saving lives. In common with thousands of other animal heroes in all parts of the United States, these horses produce, through the chemical magic of their bodies, life-saving serum. While thus engaged, they live soft and happy lives, cared for like racing champions.

And few big-time track animals win more money than some outstanding serum producers earn while working for humanity. One horse that reached a ripe old age at the serum farm of the New York City Department of Laboratories, at Otisville, N. Y., created $125,000 worth of serum during its lifetime. Jumbo, a 2,000-pound Belgian draft horse at the famous Lederle Laboratories farm at Pearl River, N. Y. has earned more than half as much. In the past eleven years he has produced 1,350,000 cubic centimeters of serum—enough to save the lives of 2,600 children.

Workmen at this 200-acre plant—one of the largest serum factories in the world—were giving Jumbo a vacuum-cleaning on

Cared for like racing champions, serum-farm horses loaf while manufacturing antitoxins in their blood

the day when I visited Pearl River recently. Each horse there receives a thorough cleaning every day. It has a stall equipped with an individual salt lick and an individual drinking bowl in which fresh water automatically begins to flow as soon as the animal starts to drink. Fly traps protect the horses from insects. And all the inmates of the five great stables receive the best of food in rations of plow-horse proportions.

The annual food bill at Pearl River, where horses and rabbits produce most of the serum but where white mice, white rats, guinea pigs, ferrets, goats, and calves play their part in making or testing serums, reads like the shopping list of a big-city zoo. It includes three tons of salt blocks, 60 tons of bran, 720 tons of timothy, 40 tons of green alfalfa, 112 tons of carrots, 280 tons of dried alfalfa, 104 tons of peat-moss bedding for rabbits, and 625 tons of mixed grain. Celery tops come to the farm piled up on trucks like loads of hay. Kale and young corn in the menu of the thousands of rabbits in the six acres of hutches help keep the animals plump and happy.

A few years ago, before the introduction of sulfapyridine cut down the demand for pneumonia serum, as many as 20,000 rabbits at a time were producing it in these seemingly endless rows of hutches. Scouts from the Lederle farm traveled as far west as Oklahoma looking for additional rabbits. One even sent back a consignment of 100 jack rabbits. In two days, they had the farm in an uproar. Some got loose in a large inclosure and nobody could catch them. Finally, men running about the pen with long-handled nets captured the animals and the jack-rabbit experiment came to an end. Today, approximately 10,000 rabbits enjoy the plentiful food and careful attention provided at Pearl River.

Lederle's animals manufacture within

Once every two weeks, each animal contributes an amount of blood proportioned to its size and weight. It takes about ten minutes to remove the blood from a horse as shown at the right, and the operation is no more harmful than giving blood for a transfusion. Below are two bottles of blood ready for processing

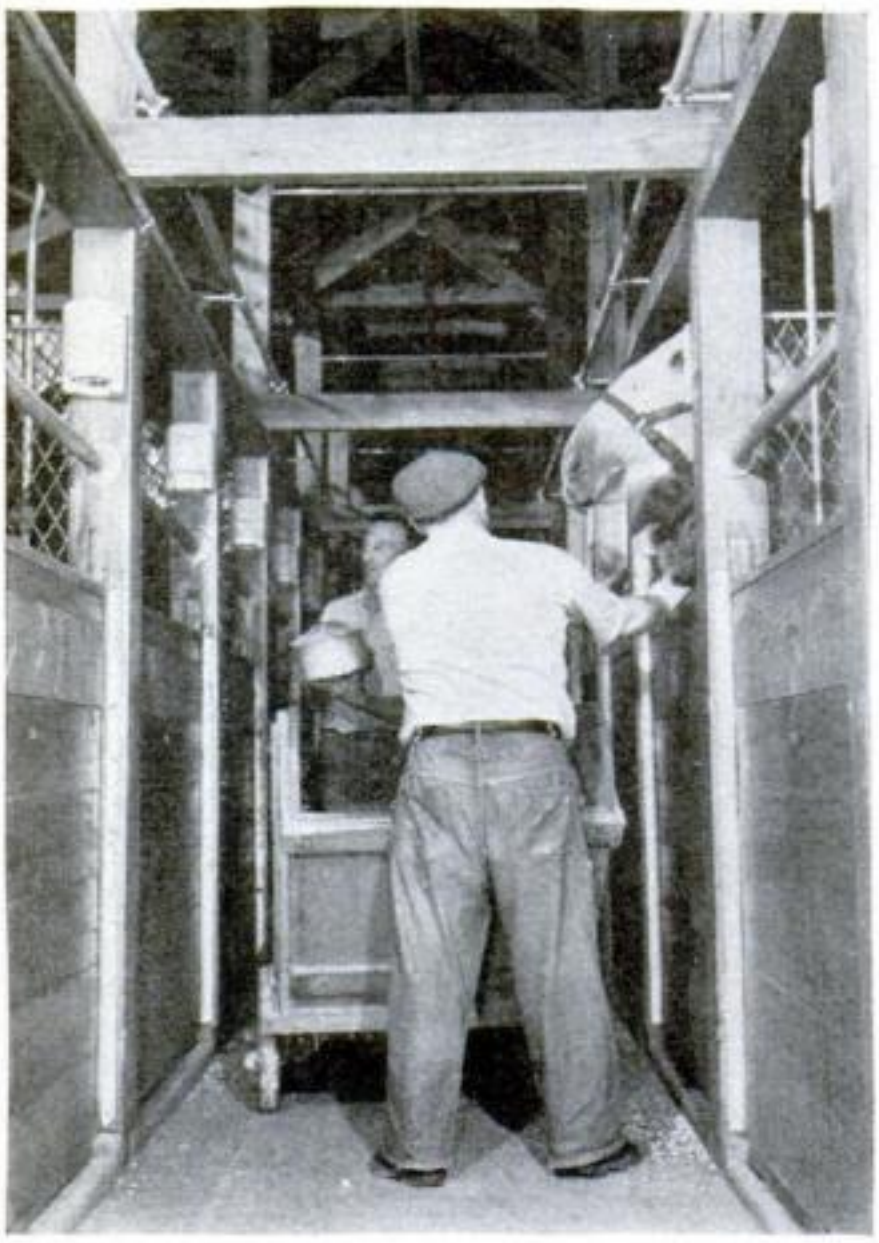
their bodies quantities of antimeningococcic serum, antistreptococcic serum, and 33 types of pneumonia serum. Two of the most recent advances in the field, the introduction of dried serum for determining blood groupings and the development of a diagnostic serum for determining the type of dysentery, are made possible by the chemical activity within the bodies of inoculated rabbits. Horses, in addition to making pneumonia and meningitis serums, produce in their blood streams substances which save lives in cases of scarlet fever, lockjaw, gas gangrene, and diphtheria. One horse is capable of producing as much serum as 130 average rabbits.

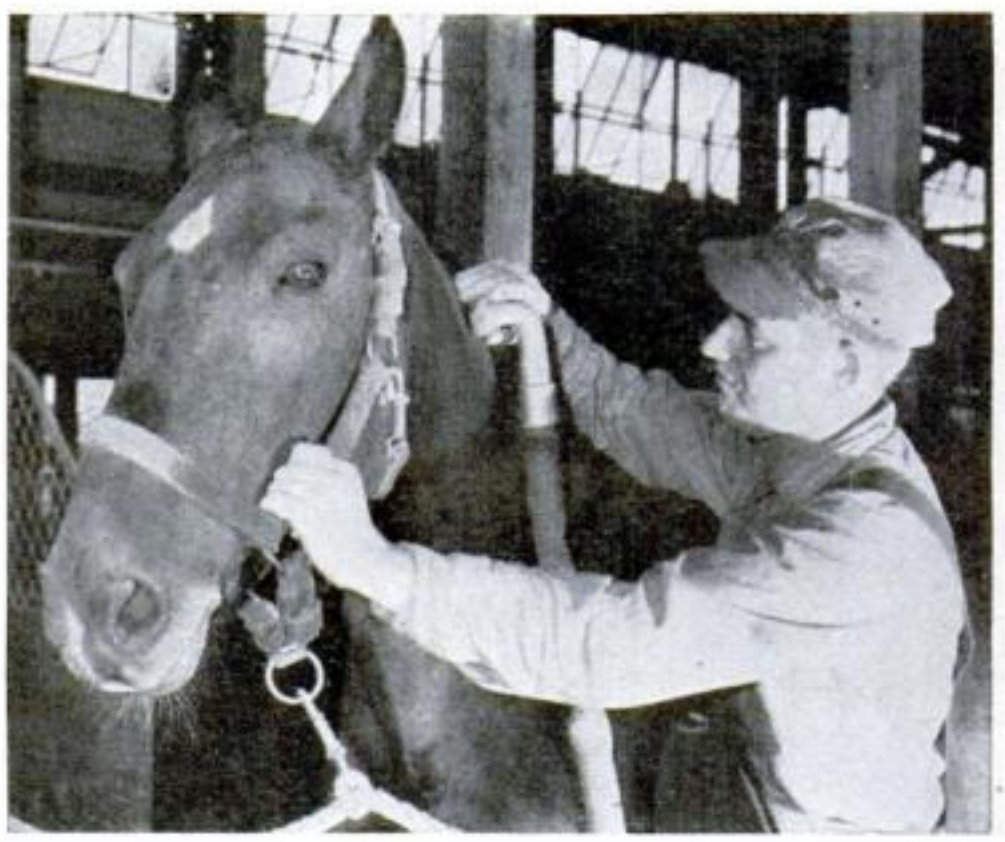
No horses or rabbits are bred at Pearl River. The rabbits are bought at so much a pound and the horses, mares, and geldings of a dozen colors, come from all over the country. Some are retired milk horses, others farm animals, still others western ranch horses with brands still on their flanks. They often arrive as run-down, skin-and-bones skates and are built up by care and good food into sleek and handsome animals. One workman cares for 25 horses or 117 rabbits. It costs approximately $1.25 a day to keep a horse at a modern serum farm. A rabbit's board and keep come to about 15 cents a day. Both rabbits and horses, when they arrive at the farm, are kept in quarantine for two weeks to check on possible infections. It takes from six months to a year of inoculations to bring a large horse to peak serum production.

Just as one cow will give richer milk than another, so some animals will produce more potent antiserum. By looking at an animal, nobody in the world can determine whether it will be a good serum producer or not. Trial alone will tell. Oftentimes, an animal that is a poor producer on one type of serum will prove much better on another. Its body reacts more violently to the latter disease. Serum strength may vary as much as 50 percent in different animals of the same species. Twenty years ago, a strength of 1,000 units a cubic centimeter was considered good. Now, as the result of scientific advances, the average runs from 1,800 to 2,000 units with 2,500 units sometimes attained.

In harvesting the serum, the amount of blood taken from an animal at any one time is approximately the same, in propor-

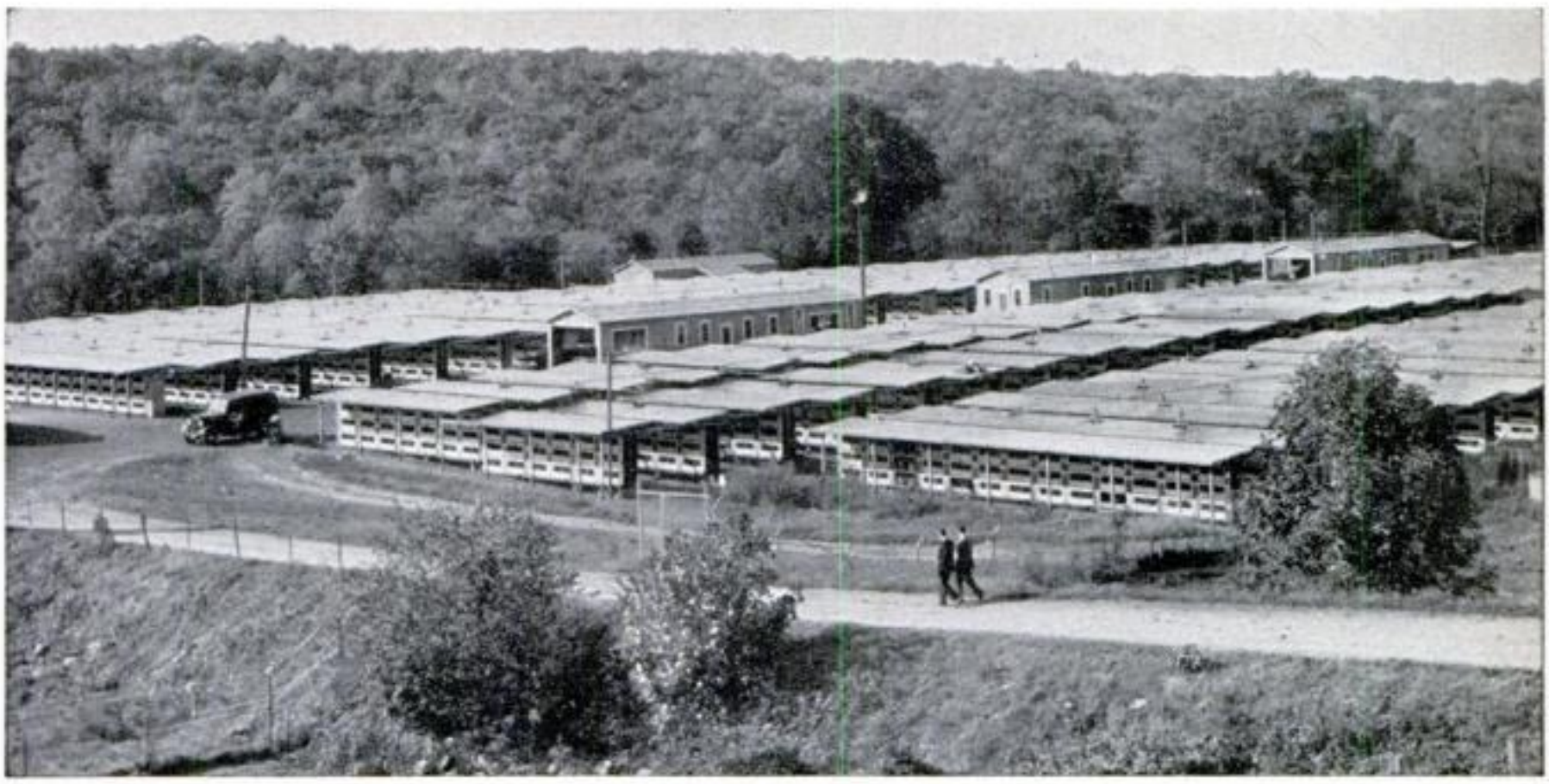
Mealtime brings a truckload of feed around to the individual stalls. Each stall has a drinking bowl in which water flows automatically as the animal drinks. It costs about $1.25 a day to keep a horse



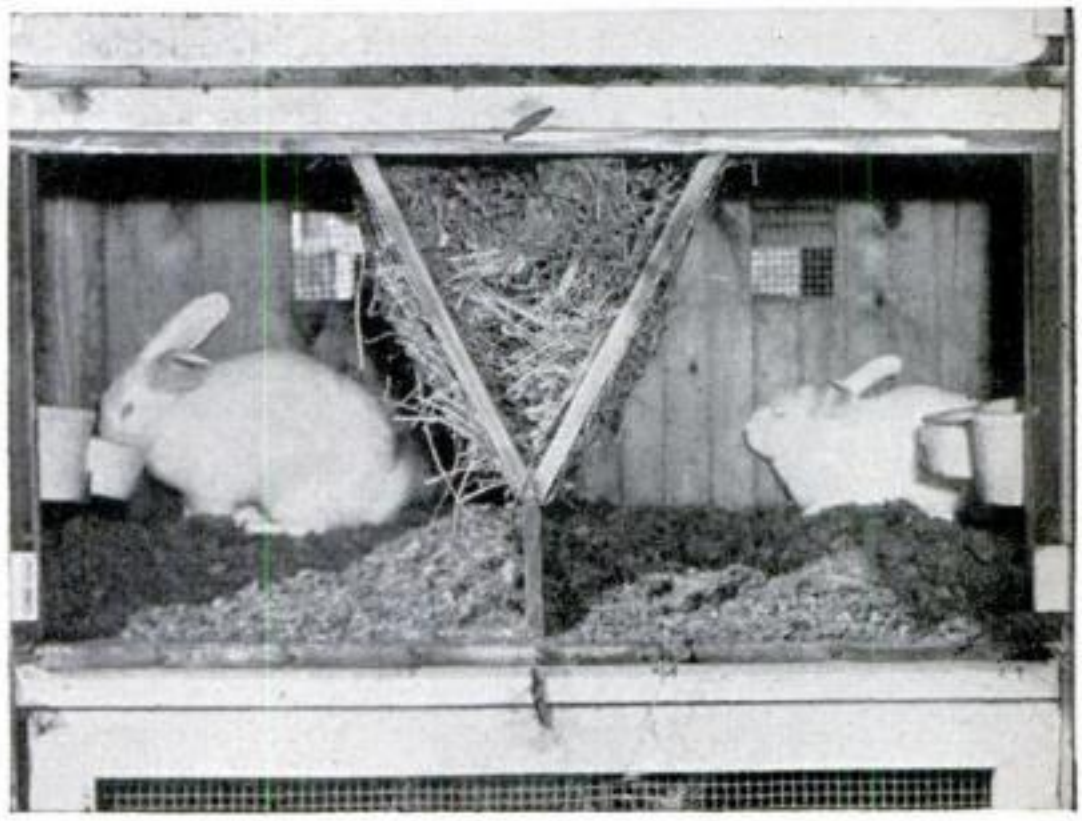


Each horse receives a thorough vacuum-cleaning every day. One man takes care of 25 horses

Fly traps in the five big stables protect the horses against insects. The annual food bill at the Pearl River farm includes three tons of individual salt blocks



Six acres of hutches house about 10,000 rabbits which help the horses make serum. Bedded on peat moss, the bunnies enjoy a scientifically blended diet including kale and young corn. Board and keep for a rabbit cost 15 cents a day



tion to body weight, as that taken from a human during a transfusion. In all animals, including humans, the life stream is equal to about one-tenth the body weight. The raw serum represents approximately 50 percent of the blood. Thus, Jumbo, during his career of nearly a dozen years at Pearl River, has contributed five gallons of blood, or two and a half gallons of serum, every month. Without harming him in any way, the hundreds of times he has given blood to produce serum have drained away more than 80 times the amount that flows through his veins at any one time.

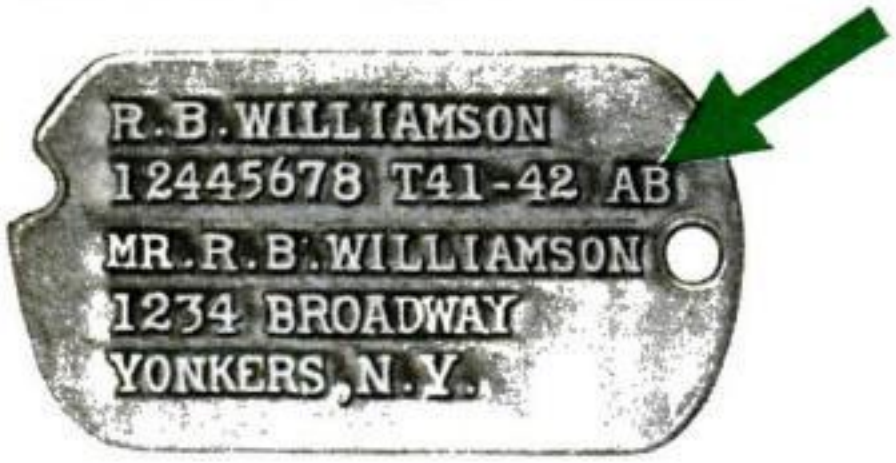
All animals at a serum farm follow the same schedule. Once every two weeks, they contribute blood according to their size and weight. Removing the blood from a rabbit requires about one minute; from a horse about ten. The animals show no ill effects. After bleeding, the rabbits hop about their hutches and the horses munch hay quietly in their stalls.

Forty-eight hours later, a fresh injection of germs starts another cycle. Outside of an occasional rise in temperature of one or two degrees, the animals show little effect from such an injection. Reaction to the germs, however, brings the serum in the life stream to maximum strength two weeks later. Thus, at two-week intervals, the serum harvest continues the year around.

Because some patients are allergic to horse proteins in serum, "the horse is taken out of the serum" during the involved process of refining. Chemical digestion of these proteins is part of the elaborate treatment given the raw material to prepare it for medical use. It requires as long as four months to get the serum from the body of the horse, where it is manufactured, into the vial, where it is ready for saving human lives. The effectiveness of the different serums is checked by tests on thousands of white mice, white rats, ferrets, guinea pigs, and even monkeys, in the laboratory.

No one knows how many lives have been saved since science put the magical faculty of animal bodies to the task of creating serums for combating human ills. New York City alone gives away $300,000 worth of serum annually. The thousands of well-fed, well-cared-for animals in American serum farms play a highly important part in preserving the health of the nation.

It's right there on his identification tag—the group to which his blood belongs, if a transfusion is necessary



U.S. Soldiers "Tagged" for Blood Transfusion

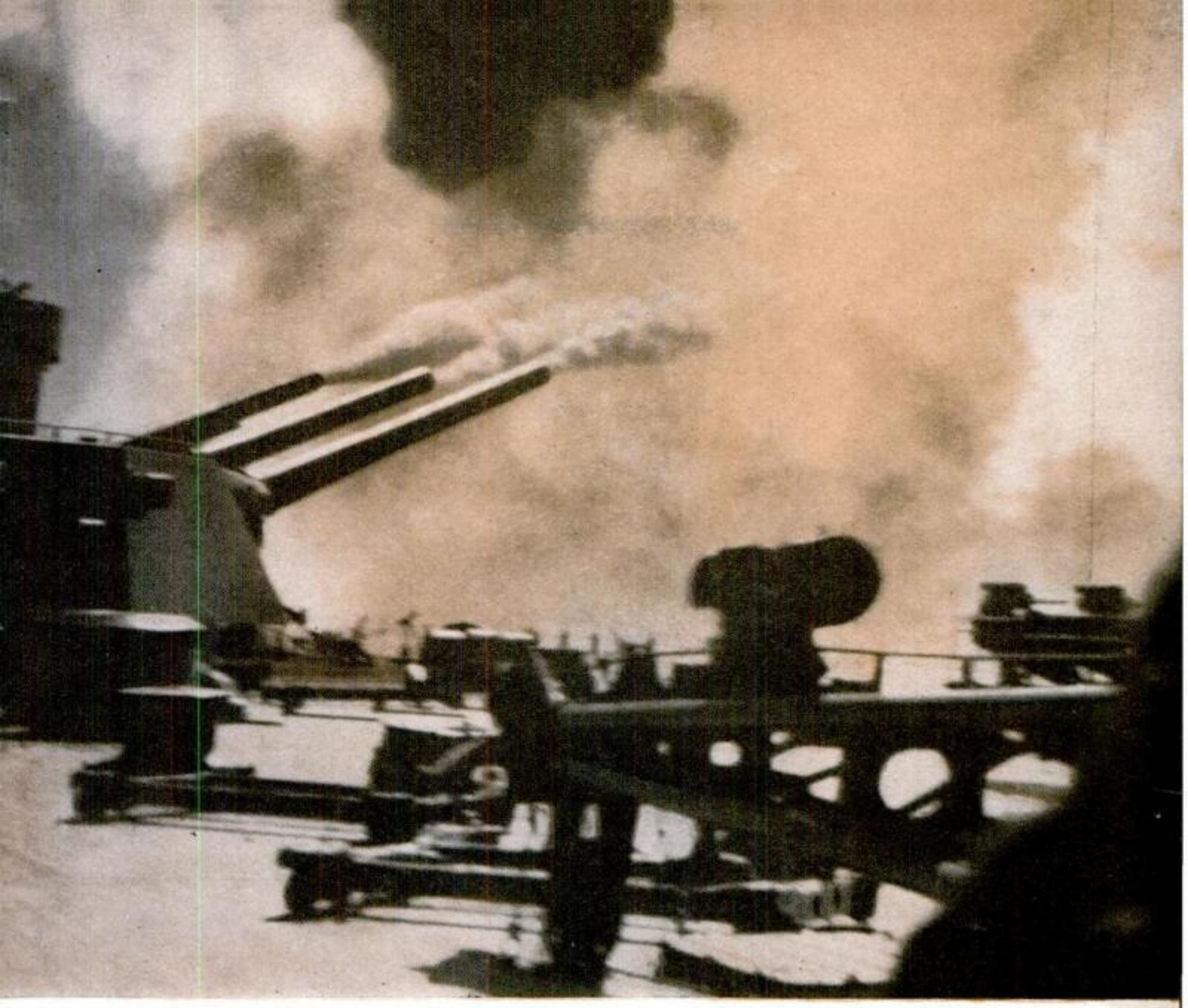
PRECIOUS time will be saved in giving blood transfusions to soldiers in the U. S. Army because each man's blood group will be stamped on his identification tag. With a new testing technique, it takes a technician only a few minutes to group the blood. In making the test, a single drop of blood is drawn from the soldier and diluted with a small amount of salt solution. Two drops of this solution are then placed on separate slips of glass and tested with dried rabbit serum of different types. By watching whether the blood clots on either drop, the technician can determine without the aid of a microscope which grouping the blood should be given. The dried and powdered testing serums are supplied to the Army in small glass tubes which are treated with a chemical to absorb moisture. Anti A serum is colored blue and Anti B, red, to insure against errors in their use.

In addition to its greater speed, this method of blood grouping is said to give more accuracy than older techniques.

A Simple Test Quickly Determines Each Man's Blood Group

To "group" a soldier's blood, a drop is drawn from his finger. This is diluted with a salt solution and a sample is placed on each of two glass slides

When the samples are tested with rabbit serum of two different types, a clot forming on one of them shows the group in which the blood sample falls

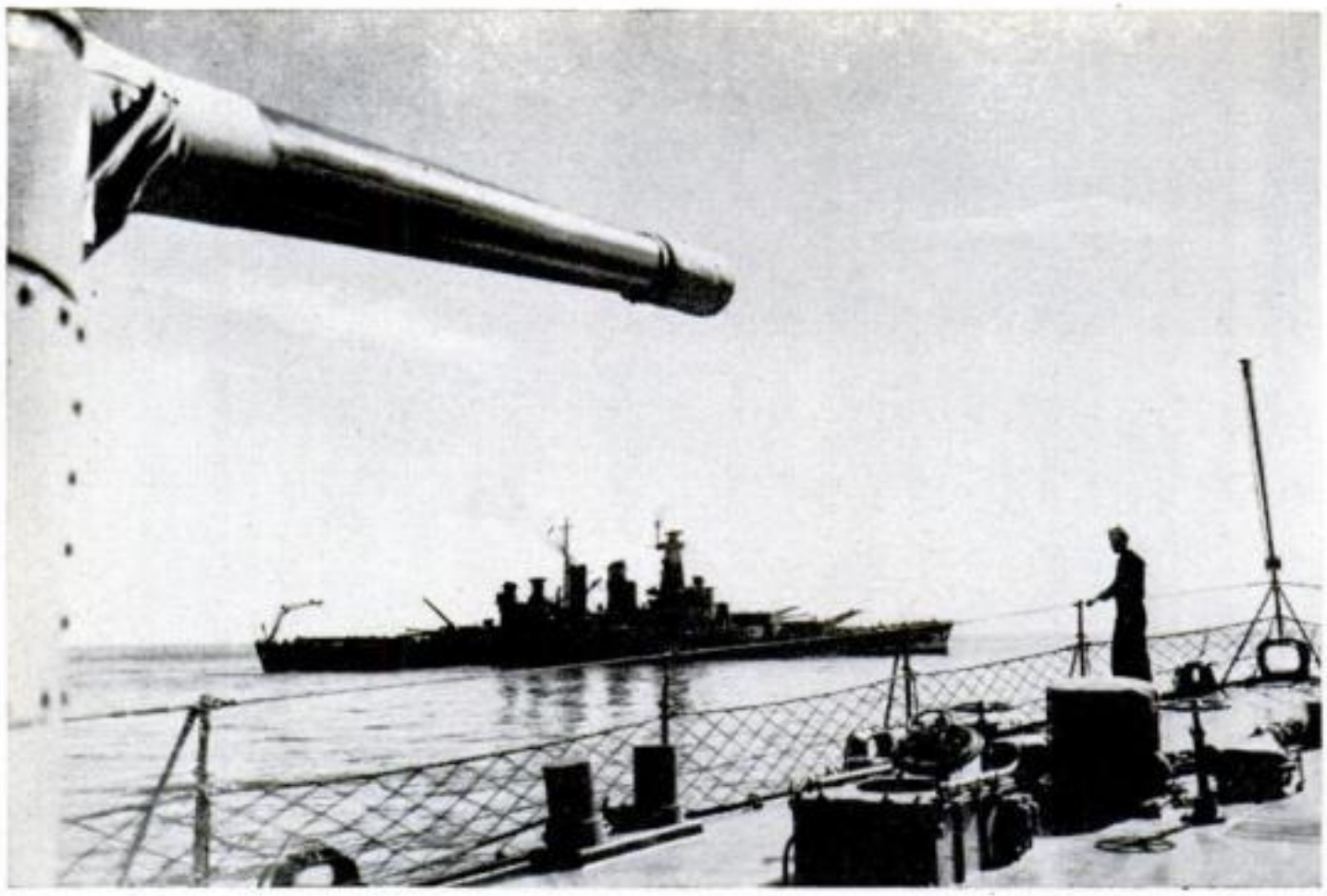


FOR THE DEFENSE OF—
America Attacked

What Brave New Weapons Gird Our Fighting Men? Carl Dreher Reveals How Embattled Industry Met The Challenge of Axis Threats to Our Freedom

A "NEW" weapon is never altogether new. Generally speaking, it is just an improved machine for killing enemy personnel and destroying enemy equipment. There is always the possibility of hitting on something spectacular and unprecedented, but Superman is a character in a comic strip and there are no supermen in the actual world of designing and operating fighting machines. For the most part military progress is a military engineering job in which a small or moderate improvement here and another one there add up to a decisive advantage in combat.

Our naval weapons are a case in point. The things they do were almost all done in the first world war and before. But the new ships do

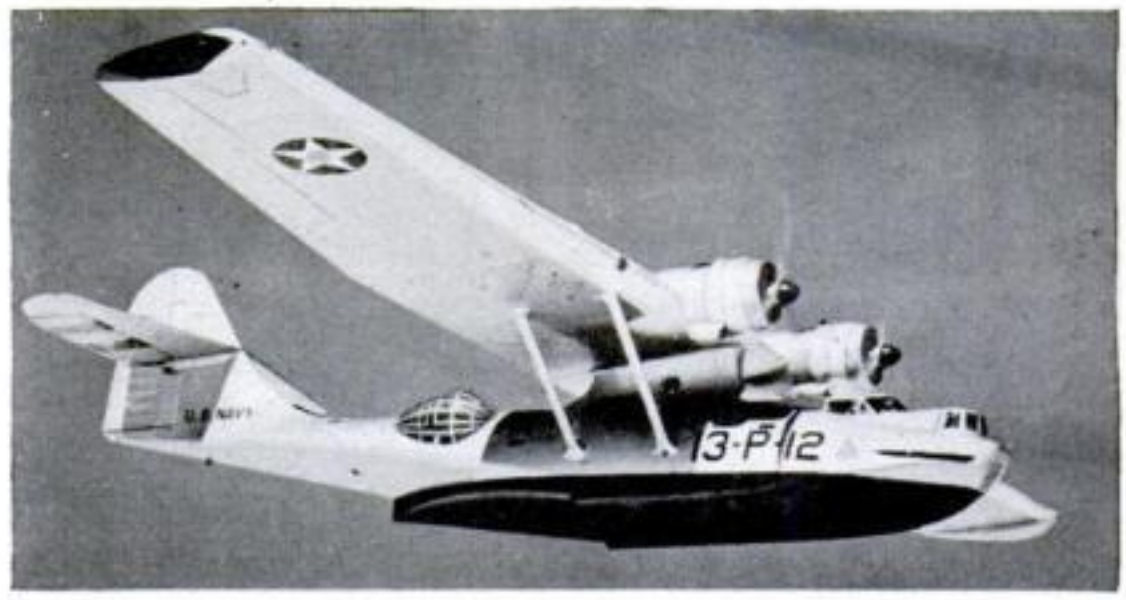


Trump card of our Navy is the battleship, represented here by the 35,000-ton North Carolina. She packs nine 16-inch, 20 five-inch guns, has a speed rating of 27 knots

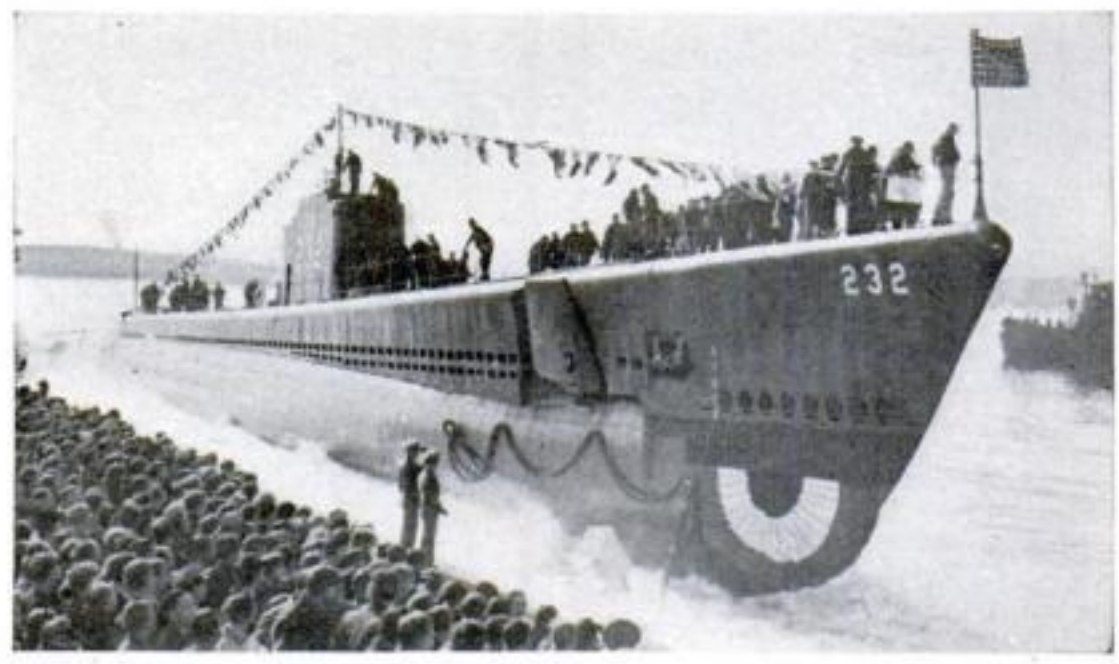
•

From the sky, the PBY patrol bomber watches the wide expanse of ocean. Its long range and hitting power make it a versatile arm

TAKE a good look at these pictures. These are the implements of war. A lot of us are going to have to use them. Their Japanese and German and Italian counterparts will be used against us, soldiers and civilians alike. The battleship ranging the surface of the sea, the patrol bomber winging its way through the sky, the submarine on its silent hunt beneath the waves, are now, and will be for a long time to come, the vital concern of every American. These are not only instruments of death, but of decision. From the decision there will be no appeal, and in the clash of these mechanical monsters of sea and land and air there will be no bystanders. The fate of our country is in the hands of our sailors, soldiers, and aviators, but the outcome depends as much on the quality of their weapons as on the skill and courage with which those weapons are used.



A new-type submarine takes the water far ahead of schedule



them faster, more accurately, and with more stunning force. Their speed is greater, because their engines are more powerful, and a further increase will soon be effected when propellers are designed with controllable pitch so that the interaction of the screw and the water pushes the hull ahead with maximum efficiency. Their fire is more accurate; the integrators and control devices split finer hairs than they used to and compensate for everything that is compensable. When the shell strikes it works greater havoc, because the rifle is bigger and the propellant powder timed for just the right shove in the barrel and perhaps the explosive in the shell is even more violent. And, not least important, the new ships are better protected against the blows which they

in turn must sustain from the enemy's guns.

The new *North Carolina* is the last word in battleships—until the next dreadnought is commissioned. In guns, speed, and armor she has no present equal in our Navy or any other. Her nine 16-inch guns, arranged in two turrets forward and one aft, are designed to hurl a broadside of some ten tons of steel and TNT over 20 miles of ocean. She carries 20 five-inch rifles as secondary armament. These are double-purpose, turret-mounted guns equally useful against sea targets and aircraft. For close work against dive bombers or torpedo planes, the *North Carolina* carries multiple-barreled 1.1 inch pom-pom guns firing one-pound explosive shells. It is a formidable aggregation of guns, something to be pondered over by the naval strategists of the Axis powers—and they will have even more to think about when the five battleships of the *Montana* class take to the water with twelve 16-inch or 18-inch guns and secondary armament to match.

In war ability to take it is as important as ability to dish it out. Torpedoes, shells, and aerial bombs may shake the *North Carolina,* kill many of her crew, perhaps disable and sink her, but it will require a greater tonnage of explosives, more accurately placed, to put her out of action than any battleship of earlier design. Antitorpedo bulges, watertight compartments, side armor probably 16 inches thick, and 10-inch deck armor are among her known protective features. Nor does she lack auxiliary protection for personnel in the form of topside armor as heavy as she can safely carry. When she must, she can run as well as chase. Her high-pressure turbines and quadruple screws will probably enable her to exceed her rated speed of 27 knots. It is ironical to talk of safety in connection with a combat ship, but the *North Carolina* is about as safe a battleship as can be designed with existing knowledge and materials.

The most highly industrialized countries, strain as they may, cannot produce battleships by the dozen. But the smaller combat craft, which can be turned out on something more like a mass-production basis, are just as important in the aggregate. These types, moreover, are being improved as rapidly as the ships of the line. New destroyers are heavier, better-gunned, and less vulnerable. The *Kearny* incident shows that a modern destroyer is no longer the

HOW THE NAVIES LINE UP

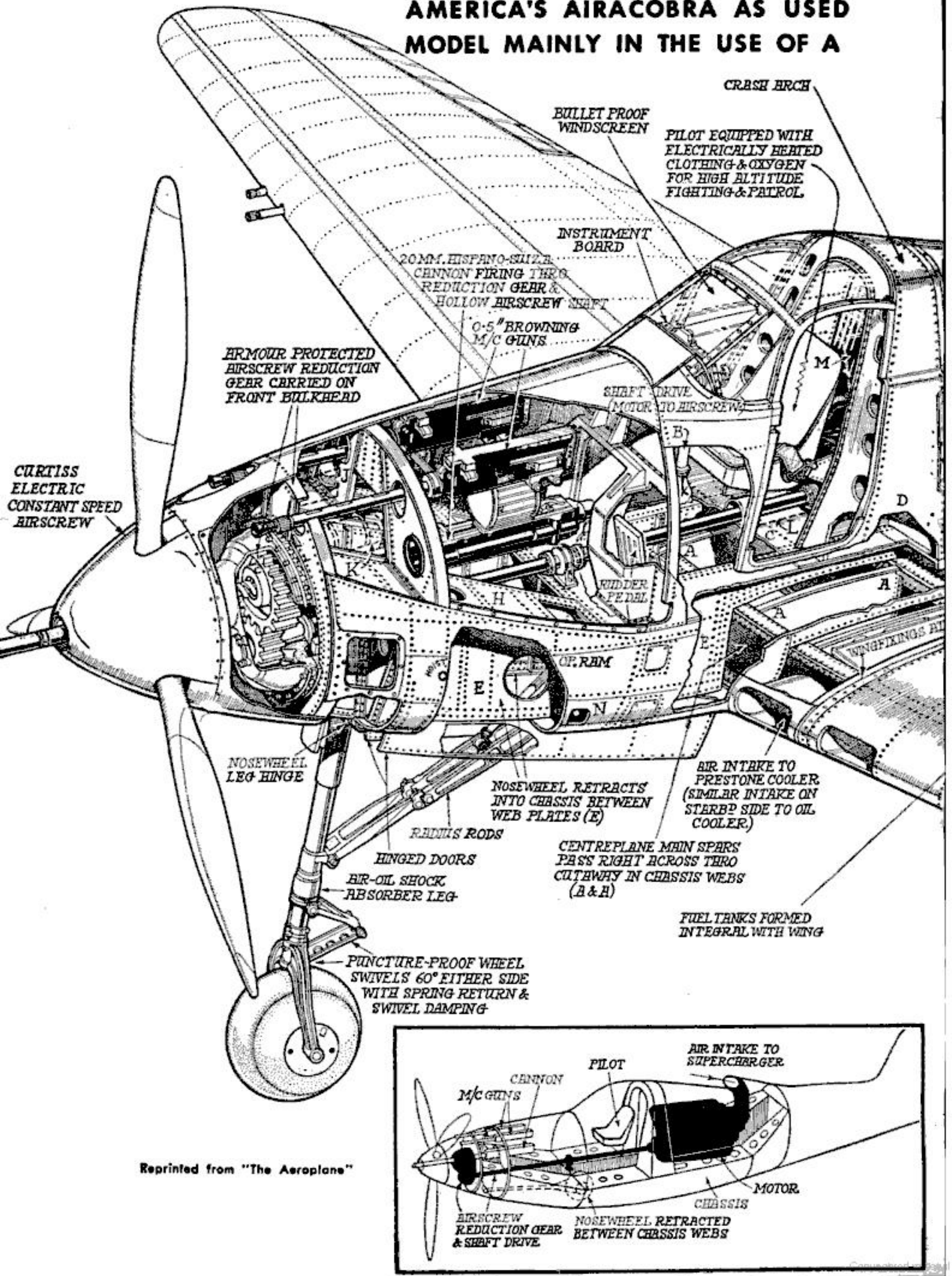
SHIPS BUILT CORRECTED TO OCTOBER, 1941. SHIPS BUILDING FROM PRE-WAR PROGRAMS

SHIPS	UNITED STATES	BRITISH EMPIRE	JAPAN	GERMANY	ITALY
BATTLESHIPS	17 BUILT 15 BUILDING	16 BUILT 6 BUILDING	10 BUILT 8* BUILDING	3 BUILT 2 BUILDING	5 BUILT 2 BUILDING
AIRCRAFT CARRIERS	6 BUILT 12 BUILDING	8 BUILT 3 BUILDING	8 BUILT 2* BUILDING	1 BUILT 1 BUILDING	0 BUILT 0 BUILDING
CRUISERS	37 BUILT 54 BUILDING	63 BUILT 14? BUILDING (NOT CERTAIN)	46 BUILT 10* BUILDING	9 BUILT 6 BUILDING	16 BUILT 14 BUILDING
DESTROYERS	171 BUILT 193 BUILDING	210 BUILT BUILDING UNKNOWN	125 BUILT 11* BUILDING	47* BUILT BUILDING UNKNOWN	101 BUILT 12 BUILDING
SUBMARINES	113 BUILT 73 BUILDING	46 BUILT BUILDING UNKNOWN	71 BUILT 7* BUILDING	120* BUILT 180 BUILDING	81* BUILT 16 BUILDING

* ESTIMATED

MODERN WARPLANES ARE

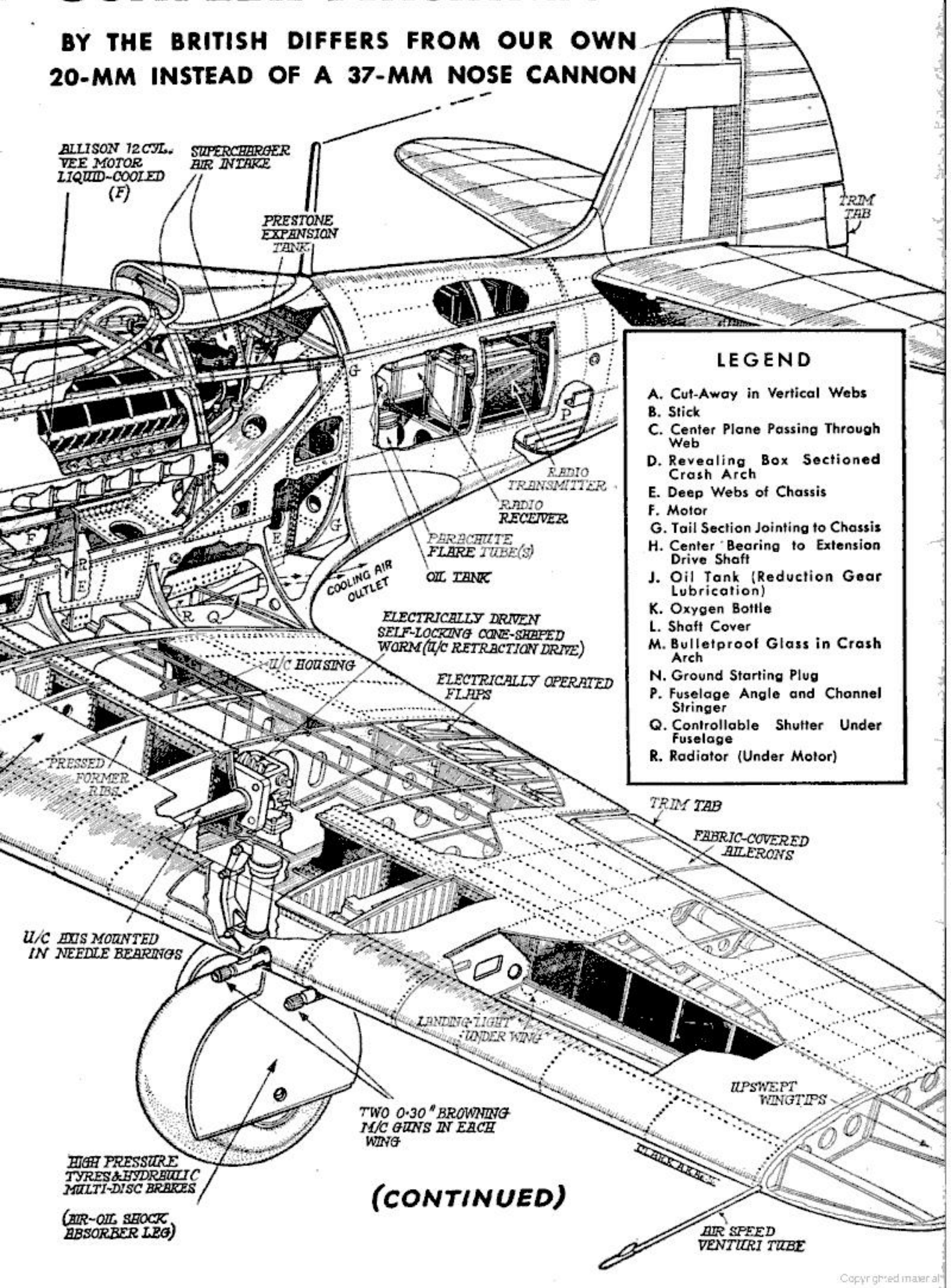
AMERICA'S AIRACOBRA AS USED MODEL MAINLY IN THE USE OF A



Reprinted from "The Aeroplane"

COMPLEX MACHINES

BY THE BRITISH DIFFERS FROM OUR OWN 20-MM INSTEAD OF A 37-MM NOSE CANNON



LEGEND

- A. Cut-Away in Vertical Webs
- B. Stick
- C. Center Plane Passing Through Web
- D. Revealing Box Sectioned Crash Arch
- E. Deep Webs of Chassis
- F. Motor
- G. Tail Section Jointing to Chassis
- H. Center Bearing to Extension Drive Shaft
- J. Oil Tank (Reduction Gear Lubrication)
- K. Oxygen Bottle
- L. Shaft Cover
- M. Bulletproof Glass in Crash Arch
- N. Ground Starting Plug
- P. Fuselage Angle and Channel Stringer
- Q. Controllable Shutter Under Fuselage
- R. Radiator (Under Motor)

(CONTINUED)

type of vessel which only has to be hit once and it is headed for the bottom. The modern destroyer is more like a light cruiser in this respect, and there will be even less difference in the future. The typical American destroyer of current design displaces 1,500 tons and up, with the heavy destroyers which act as squadron leaders running as high as 1,850 tons. On the offensive, such ships, mounting eight to 16 torpedo tubes, six 5-inch guns, and a heavy complement of smaller high-angle guns for action against airplanes, are a match not only for opponents of their own size but often for those considerably larger. Their principal advantage is high speed and extreme maneuverability, consequent on their tremendous power plants, which are about ten times bigger, in engine horsepower per ton of hull, than those of battleships. The destroyer, of course, is the weapon par excellence against the submarine, and it is equally indispensable for screening, scouting, convoying, and auxiliary operations.

The destroyer is fast and maneuverable, but the ultimate in speed and marine acrobatics is reached in the motor torpedo boats, which tear through the water, or rather on it, at speeds around 60 miles an hour, and turn corners like a boy on roller skates. Carrying three supercharged 1,350-horsepower engines and a complement of eight men, a boat of this type is by no means inexpensive either in a monetary or a military sense. Still, it can be risked and if necessary lost with less over-all damage than a larger fleet unit, and on the other hand it constitutes an entirely disproportionate hazard for any battleship at which it aims its four torpedo tubes. If the battleship blows the mosquito boats out of the water the battleship has accomplished substantially nothing, while if the torpedo finds its mark there is likely to be one less battleship and the mosquito boat has accomplished substantially something. The essence of war is to do the greatest possible damage with the least possible expenditure of men and equipment, and the mosquito boat is one of the solutions of this problem as far as naval warfare is concerned.

A navy worth its taxes is not a random conglomeration of ships, but a technological unity like any other producing organization. It happens to produce destruction instead of goods, but that in no wise lessens its need for first-rate coördination in operation, maintenance, and all the other highly technical functions which keep the wheels turning. The range of these activities is so great that even a cursory description is impossible. But one phase of the Navy's special operations warrants description because of its certain future importance, and the more so in that it entails joint maneuvers with the Army—always a difficult situation for both services. The job is that of transporting troops over water.

In the last war, Army units carried overseas were regarded more or less as human freight: so much space had to be provided to accommodate so many men, and the ships assigned to this duty were simply freighters or passenger vessels rebuilt to carry as many troops as possible. Since this was before the days of air power and there was no problem of landing troops on a hostile shore, this system functioned successfully enough at the time. But the present war will call for establishing beach heads and landing large bodies of troops under fire. Consequently it has been necessary to adapt existing oceangoing bottoms to carry seagoing combat units with all their equipment, ready for action, and in addition to devise means of getting the men and matériel off the transports to the beach. The latter job is handled by armed, self-propelled, shallow-draft landing boats between 36 and 45 feet in length. Powered with a 250-horsepower motor and protected by a machine-gun turret in the bow, such a boat can bring to shore from 40 to 190 fully armed men, or a smaller number of men and a light tank. The speed is 25 knots. When the boat runs up on the beach, the hinged end is lowered to provide a runway for the tank or other vehicle.

The failures and fiascoes of American plane production in World War I are an unpleasant memory. In the present war American plane design promises to write one of the most brilliant chapters in the whole history of air technology. Our only problem is reaching peak production in time. The models themselves can hardly be praised too highly—and this is not the opinion of the men who built them, but of foreign pilots who have been fighting in them. The planes are good all along the line, from the smallest pursuit craft to the heaviest bomber. The light bomber or attack plane—Douglas A-20-A—used by the British as a night fighter under the name "Havoc," is only one example. In the United States it is used largely as a reconnaissance bomber and in close support of ground troops. Flying at very low altitudes, the A-20-A blazes away at a supply column with its forward machine guns and drops parachute-retarded fragmentation bombs behind. The A-24 dive bomber metes out similar punishment to point targets.

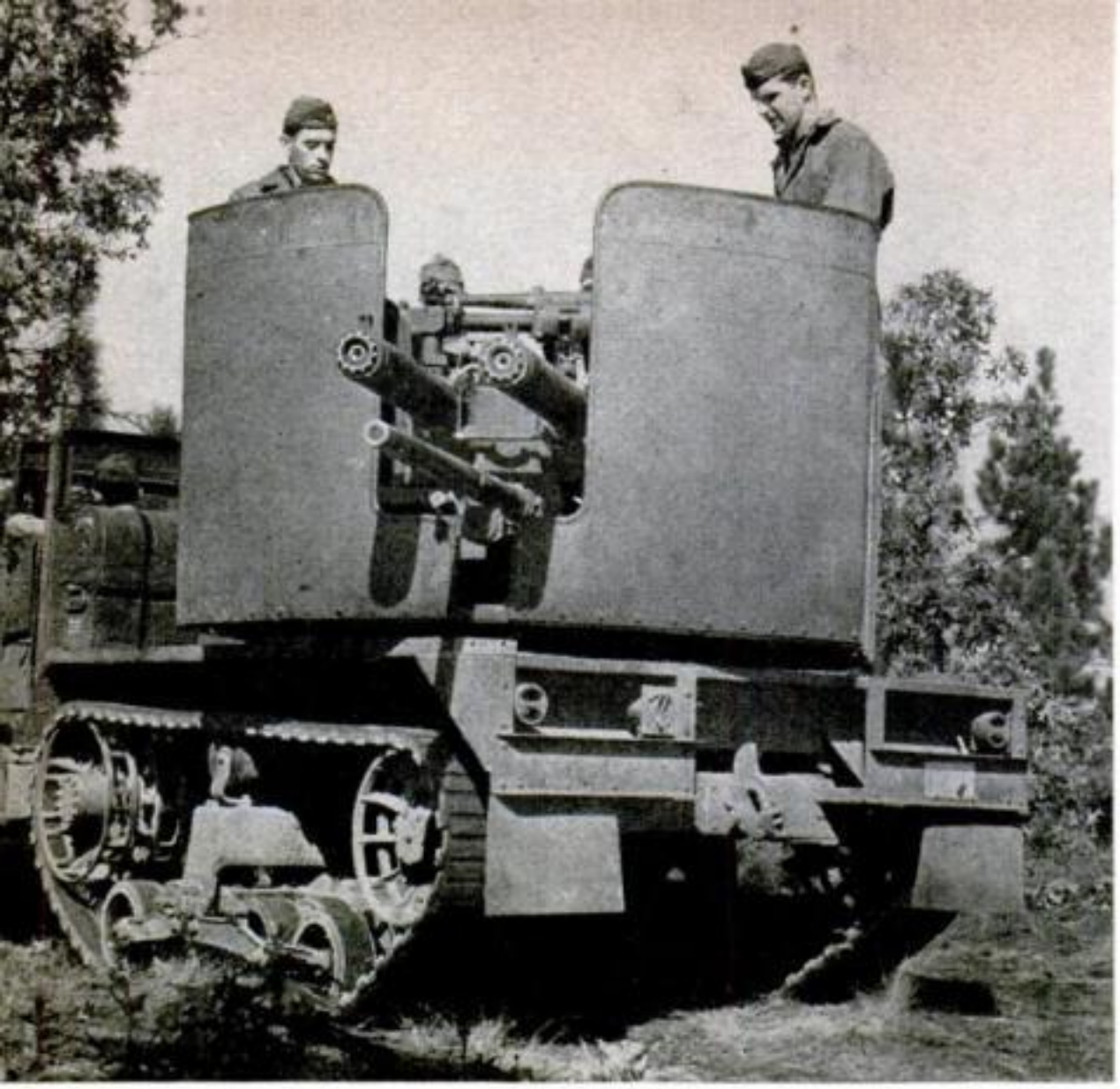
The Army's medium bombers fly as fast as some of the best 1941 European fighters. American heavy bombers climb to 37,000 feet and at the higher altitudes are capable of running away from most fighters within

Army's newest self-propelled weapon is this anti-aircraft unit which combines a 37-mm. cannon with two .50 caliber machine guns, set on a half-track

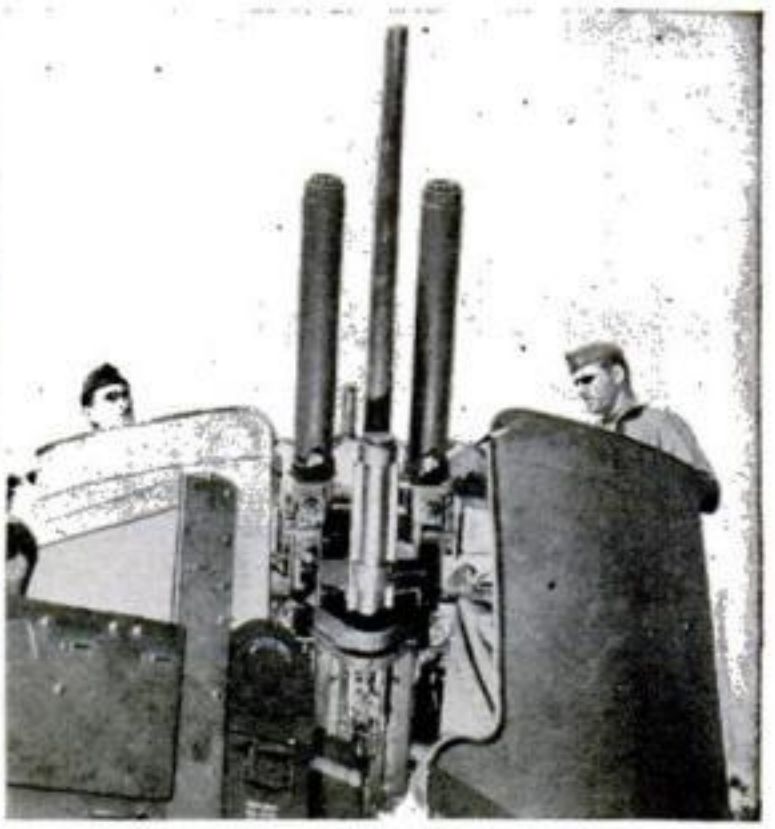
Triple Threat to Dive Bombers

their bombing range of 3,000 miles. As a sample of the heavier bombers to come, the 80-ton Douglas B-19, with a wing spread of 210 feet, has four engines totaling 8,000 horsepower which will fly it 6,000 miles at a speed of 200 miles per hour. In the interceptor and pursuit line we have some of the fastest models in the world. Something may also be said of the less publicized training planes. In the long run, trainers may be only less important in the winning of the war than fighters and bombers.

The U. S. Navy, which has been building some of its own planes since 1918, is conceded to have the best naval air force in the world. Its patrol bombers are vital for coast defense, locating commerce raiders, and the like, and in a war of attrition will assume even greater importance. It will be remembered that it was a Catalina (Consolidated PBY-5) flying boat which intercepted the *Bismarck* on the voyage which ended in her destruction. The Navy pioneered the technique of dive bombing and in this field it has the Douglas SBD Dauntless, which corresponds to the Army's A-24, and the Curtiss Helldiver, SB2C-1, which is said to be the deadliest of the lot. Another U. S. Navy development is the torpedo bomber, and its Douglas Devastator (TBD)

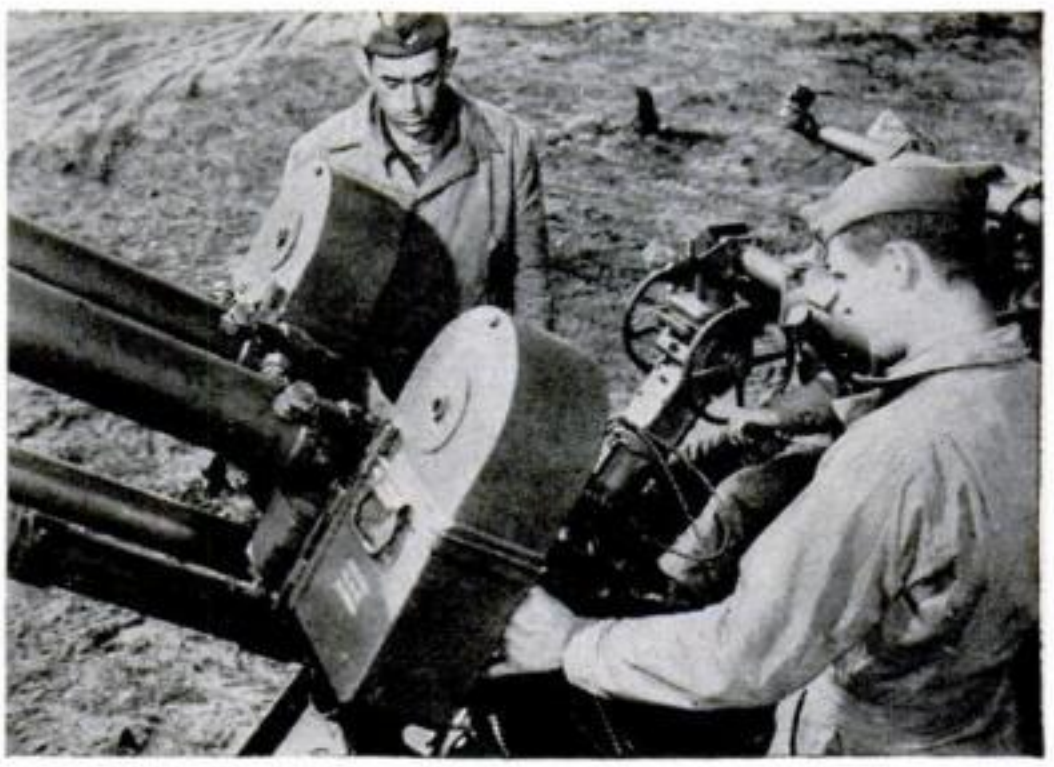


In this model, armor has been added. For use against tanks, the guns can be depressed, as shown at left, to about five degrees below horizontal



A seven-man crew fights the self-propelled antiaircraft weapon: driver, commander, two loaders, two gunners, and a range setter. Radio equipment keeps the commander in touch with command and reconnaissance units. All guns fire tracers. One gunner sights at the target for elevation, one for azimuth . . .

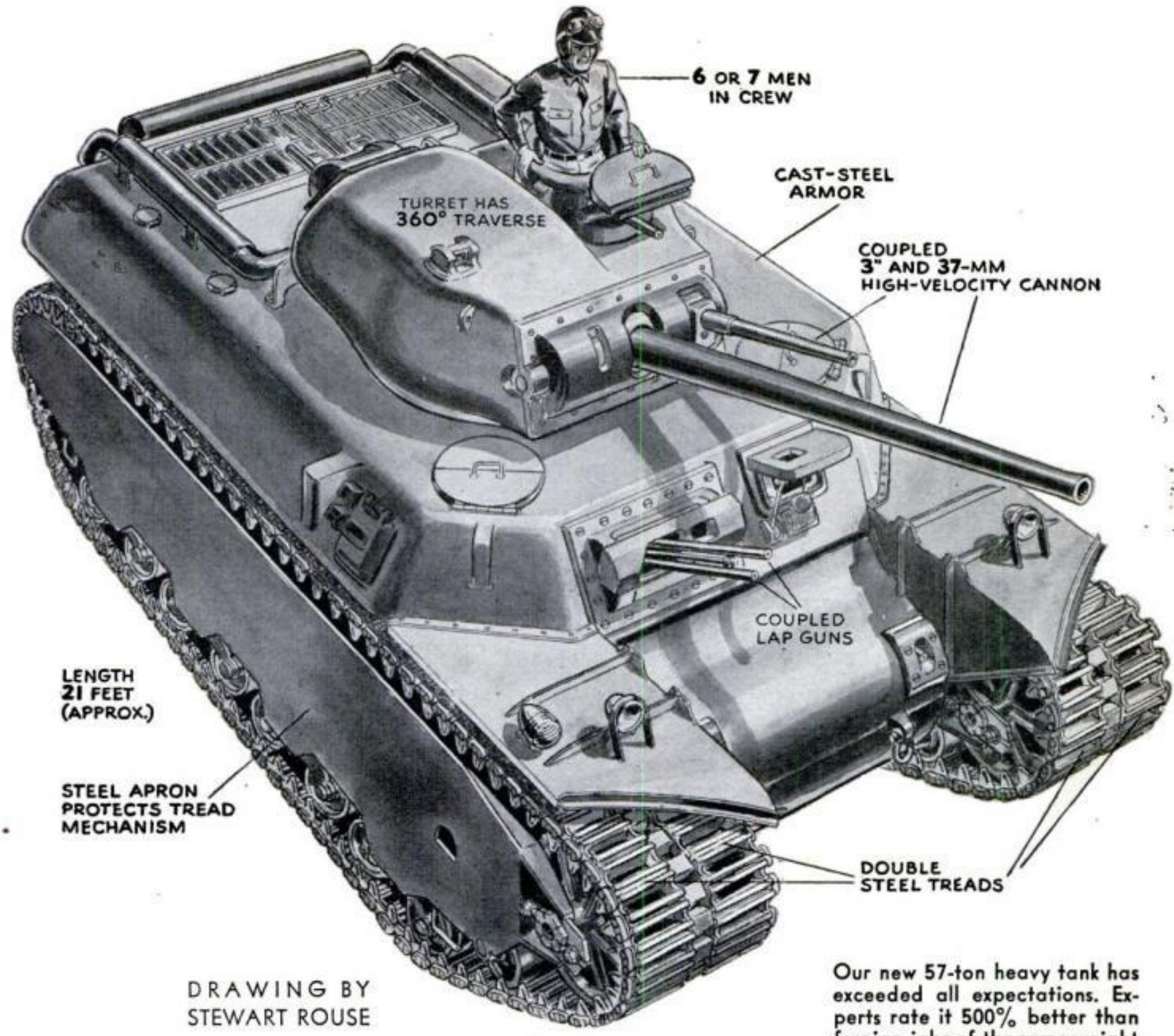
. . . while the highly skilled range setter sits between them and manually adjusts the sights to "lead" the target with the triple stream of fire



Ammunition tenders in action: The man at left loads the .50 caliber on that side. The man at right loads the other machine gun and the "37"

Standing on a platform that revolves with the guns, the ammunition tenders ride around with the traverse as it follows fast-moving targets

The right-hand gunner fires all three guns with his feet. His left foot operates the trigger of the two .50's, his right the automatic cannon



DRAWING BY STEWART ROUSE

Our new 57-ton heavy tank has exceeded all expectations. Experts rate it 500% better than foreign jobs of the same weight

is much better than the British Swordfish which knocked out a good part of the Italian Navy at Taranto.

Naval antiaircraft equipment has already been mentioned in connection with the U.S.S. *North Carolina*. During 1942 the Army will have available in quantities its 4.7 inch AA gun, which should be effective in the substratosphere region where heavy bombers now travel. For medium altitudes the Army, on the basis of European performance and its own tests, has adopted the 40-mm. funnel-mouthed Bofors automatic cannon, which fires in bursts of four or five rounds with a muzzle velocity of 2,850 feet per second and has a virtually

Use of welded armor plate for tanks eliminates the hazard of rivets banging around inside when shells hit. While some makers turn out tanks this way . . .

. . . other plants equipped for foundry work can be making cast-steel turrets like the one pictured below, which also dispenses with the use of rivets

straight trajectory up to over 9,000 feet. The weight of the projectile is 2.2 pounds, and it will tear apart any airplane wing it hits, or knock the plane out of control if it explodes nearby. It is not a new weapon, nor of American origin, but part of the knack of winning wars consists in holding on to old designs until something materially better offers, and in borrowing whatever is good, wherever it is found.

The great new development of the current war is, of course, mechanized warfare, of which the Nazis have been the chief protagonists to date. In this connection a recent writer in the austere "Command and General Staff School Military Review" quotes dryly, "There ain't no holt what can't be broke." And that sums up the situation accurately and briefly. Masses of tanks and armored divisions are powerful weapons, but mechanism can cope with mechanism—a principle which the hitherto invincible German armies have already encountered in Russia, and will no doubt run up against on other battlefronts.

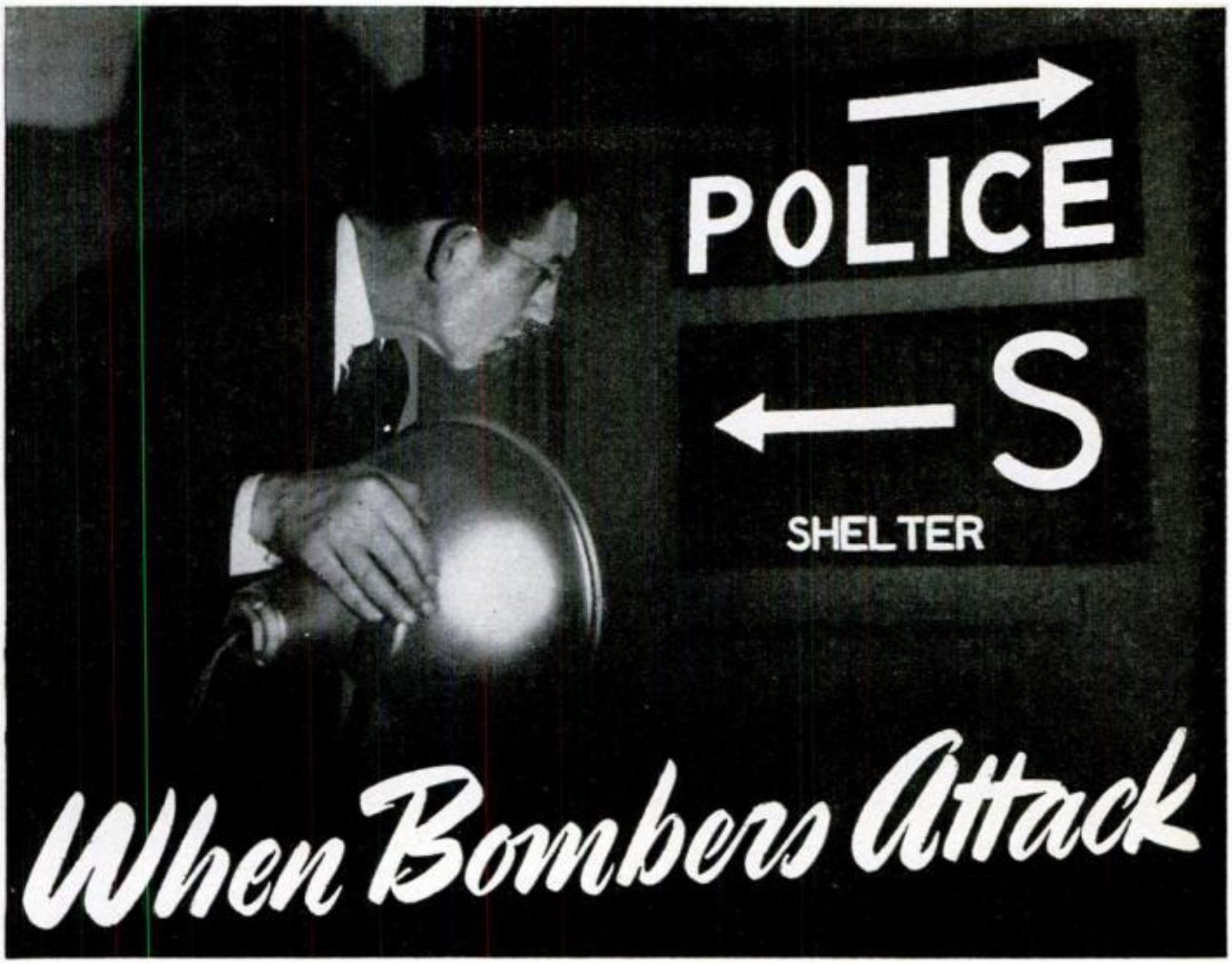
The trend in tanks has been toward heavier types, with armor good against at least 40-mm. projectiles. American production has been largely confined to the light tank of about 15 tons, which has given a good account of itself in Libya and, by reason of high speed, good maneuverability, and mechanical excellence, can under some conditions cope with equal numbers of German medium tanks. It is normally equipped with a 37-mm. gun and several machine guns. During 1942 our 28-ton medium tank will be brought into heavy production and is expected to come up to the mechanical standard of the light model. Armament consists of a 75-mm. cannon, a 37-mm. cannon, and machine guns in the turret and cupola. The first heavy American tank passed the Army tests at the Baldwin Locomotive Works early in December, 1941. It weighs 57 tons, mounts one 3-inch and one 37-mm. cannon and a battery of machine guns fore and aft, and has exceptionally high speed for its weight.

The most obvious defense against the tank is a better tank, or, if tanks are unavailable, an anti-tank gun heavy enough to pierce the attacking tank's armor. Such a gun must be self-propelled and lightly armored to afford some protection to its operators. Essentially, therefore, it is a light, single-gun tank in which armor has been sacrificed for the sake of speed and maneuverability. One tank specialist estimates that a given number of AT guns can cope with three to four times as many tanks. The United States has developed self-propelled guns in calibers from 37-mm. to 155-mm., the 37-mm. and 75-mm. sizes being designed especially for AT operations, or, as they have lately been designated, tank destroyers.

A recent development in tank construction is the use of cast or welded steel bodies. The 57-ton type mentioned above is of this type. Earlier tanks, such as the American product used by the British in the Libyan campaign, were riveted. When anything has to withstand great pressures, it is usually best to make it one piece. In the case of the tank, rivets have the additional disadvantage that when struck by an armor-piercing shell they may be driven into the interior as secondary projectiles.

In an age of total war there is no practical distinction between military weapons and the weapons of civilian production. An improved method of geophysical exploration for petroleum might help to win a war as much as an improved machine gun. A medical development, such as an improvement in psychaitric tests used in selection of student flyers, might be a military factor of outstanding importance. Organization itself is a weapon: a body like the National Inventors Council, which sifts defense inventions and separates a few kernels of wheat from a vast volume of chaff, is not to be underestimated. In this field of scientific organization, incidentally, we are likely to gain a long-term advantage, because while the Nazis are superlatively organized for the application of science to the ends of destruction, their methods of internal suppression and persecution are likely in the end to dry up the sources of invention. Germany nearly won the last war with Fritz Haber's fixation of nitrogen from the air; there will be no Haber for them this time, for he happened to be a Jew.

The battleships, tanks, planes, guns, vehicles with which our men will fight are good, and the men are good. What then are the prospects? All that can be said is that the short-term outlook is poor, the long-term outlook favorable. We were not ready when we entered the war and shall not be thoroughly equipped for some time. But we have the men and the machines and the production capacity to see it through. And, not of least importance, we are learning from our mistakes. To work and to learn, to be energetic and educable, is in the last analysis the primary national weapon for which there is no substitute in war.



HOME PROTECTION IS IMPORTANT TO AMERICAN DEFENSE—HERE ARE THINGS YOU SHOULD KNOW

"WHAT should I do in case of an air raid?"

To millions of Americans on both coasts, wailing sirens have brought home that question. The cool-headed civilian who knows all the answers, and acts promptly upon them, serves both himself and his country.

At home, safety measures against air raids can be taken in advance.

In areas subject to nightly blackouts, turning out lights or drawing shades is a makeshift procedure. Breezes from an open window may flutter the shade and expose a gleaming slit of light, when it is inconvenient to keep the room dark. Londoners, who formerly put up with the stuffiness of closed windows on hot nights, now have devised permanent blackout windows with ventilation. Beneath a window covering of black, opaque cloth is mounted a trough-shaped ventilator, which any handy man can easily make. Painted dead black to avoid reflection, it contains a baffle that acts as a light trap, while allowing free passage for fresh air.

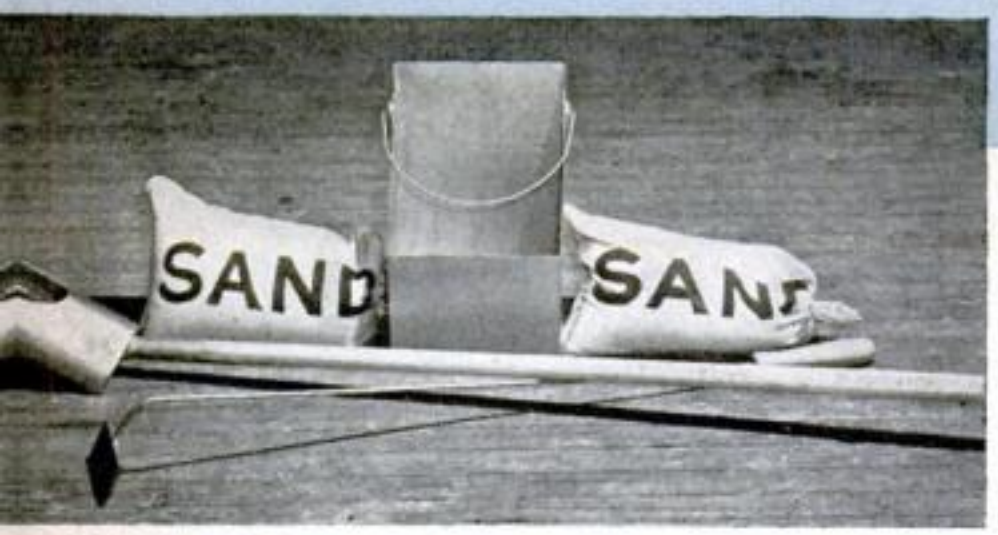
If bombs fall in residential sections, the chances are that they will be of incendiary type. A favored sort weighs about two pounds, measuring 14 inches long and two inches in diameter as shown on page 66. Its thermite filling ignites its magnesium-alloy casing, which burns with intense heat for a quarter of an hour. A single plane may scatter hundreds of these bombs upon dwellings, saving its heavier missiles for more important targets.

Such an incendiary bomb can easily pierce a roof, burn its way through the attic floor, fall to the floor below, and set the upper stories of the house afire—if no precautions have been taken against it. But a home owner can safeguard his dwelling, and even act as his own fireman in case of need, as

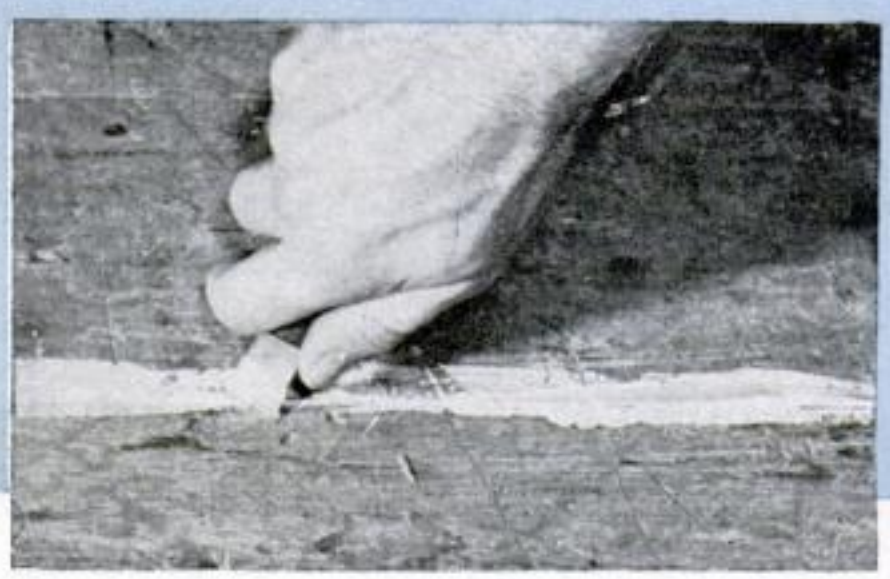
The picture above shows how invisible light can be harnessed to blackout needs. Signs coated with fluorescent chemicals glow in almost complete darkness when they are activated by ultraviolet light

PROTECTING THE HOME AGAINST FIRE BOMBS AND HIGH EXPLOSIVES

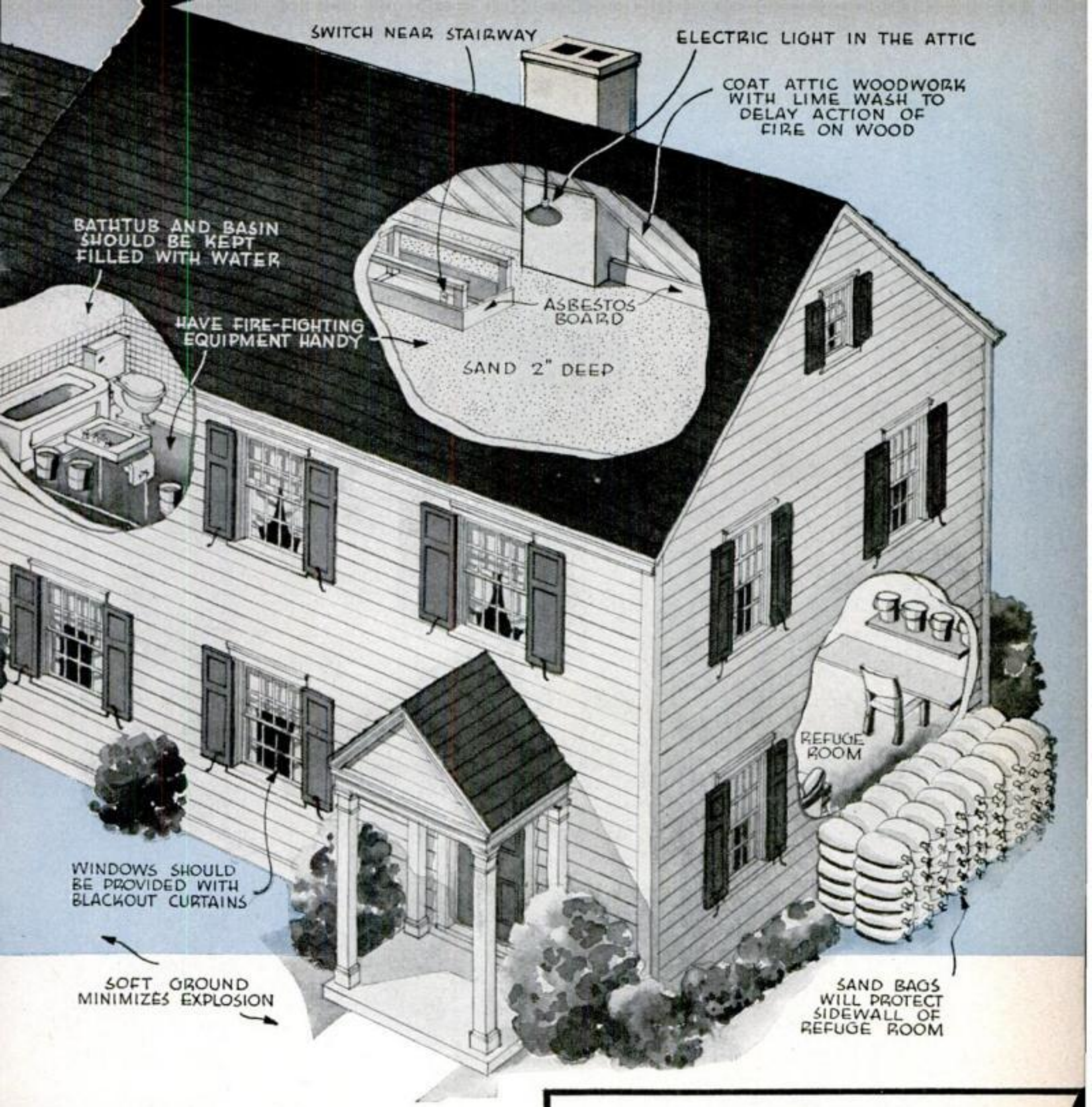
Preparing an attic to resist incendiary bombs. A strip of asbestos board is placed around the walls at the floor line and stair wells are similarly edged. Two inches of sand covers the attic floor



Fire-fighting kits: The one above has sand, bomb scoop and rake, bucket. The more elaborate set below has sand, snuffer, stirrup pump, portable pump



Before putting sand on the attic floor, all cracks should be filled with asbestos cement to prevent blazing chemicals from seeping through. A coating of lime wash on the walls and other woodwork will help to delay the action of fire at those points



described in a manual recently prepared for Government use by eight of the country's leading fire-prevention experts.

Trash, paper, and all other easily combustible material should be cleaned out of the attic. Furniture, trunks, and boxes go out too. Not only do they feed the flames, but they will get in the way of fire fighters. Also, if walls close off some of the indoor space beneath the roof, doorways should be cut through them.

If the roof is flat and will stand the weight, a two-inch layer of sand is recommended. Likewise the attic floor should be boarded over, to cover exposed rafters, and should receive at least a two-inch layer of sand, ashes, finely sifted earth, or other

EQUIPMENT FOR REFUGE ROOM

(Reprinted from Popular Science, May, 1941)

Tables and chairs.

Water for drinking, washing, and fire fighting.

Books, cards, writing materials, toys.

Large fire buckets.

Stirrup hand pump for water.

Sand and shovel for extinguishing incendiary bombs.

Paper and paste or gummed paper for covering window panes and sealing cracks.

First-aid kit.

China and cutlery.

Canned food and can opener.

Food chest with gas-tight containers.

Sanitary facilities and disinfectant.

Spare blankets or rugs for resealing windows.

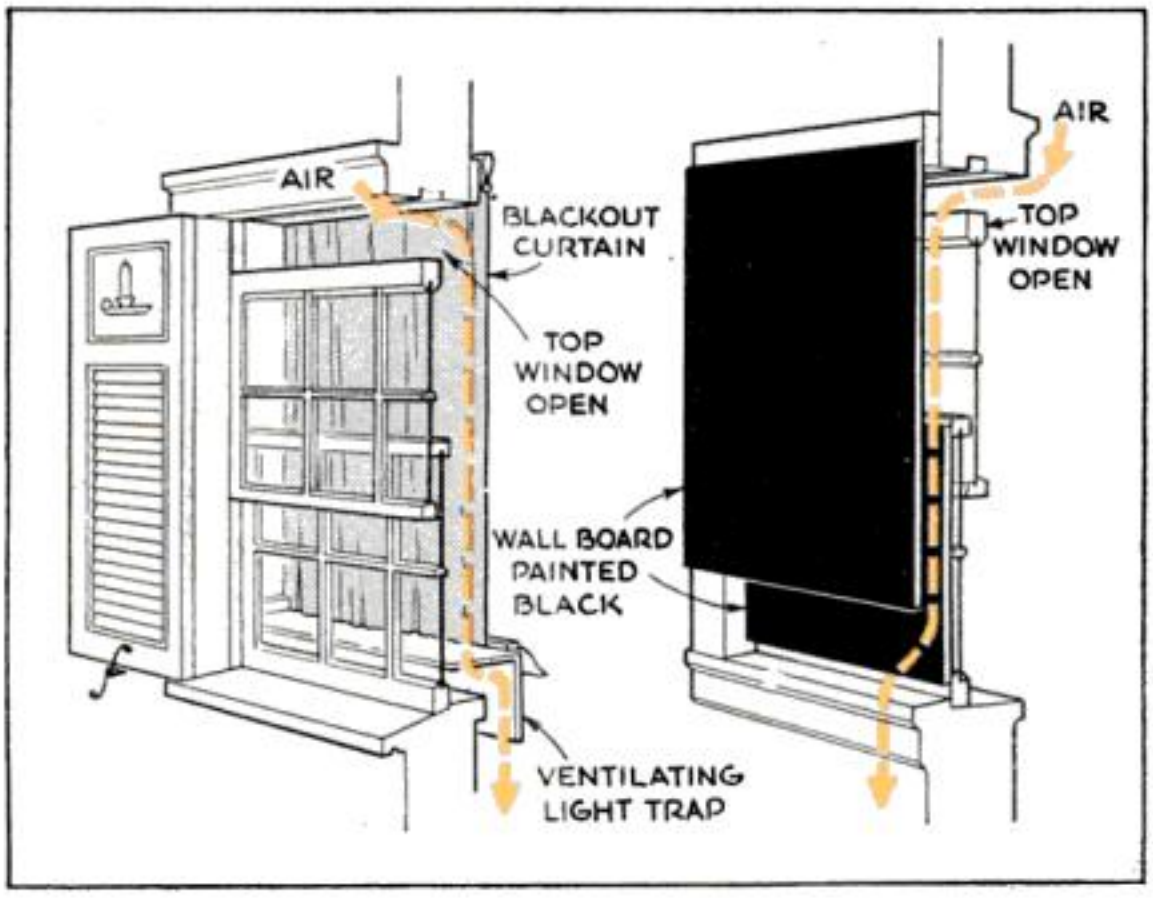
Pickax and shovel for clearing debris.

Electric grill for cooking and heating.

Flash lights and matches. Mattresses, blankets, and other coverings.

Radio receiver.

Raincoats, rubbers, and gum boots.



Ventilation is possible even with complete blackout. This drawing shows two methods of treating windows to keep light in, admit air

fire-resistant material. Corrugated iron is not advised for this purpose; it may get red-hot and spread the fire, as well as resist an ax if it becomes necessary to get at the rafters or ceiling below the floor.

A bucket of sand should be placed on each of the two upper stories; two or three more buckets should hold at least 10 gallons of water; and 12 to 15 feet of garden hose, with a quick-coupling connection for a water faucet, should be at hand.

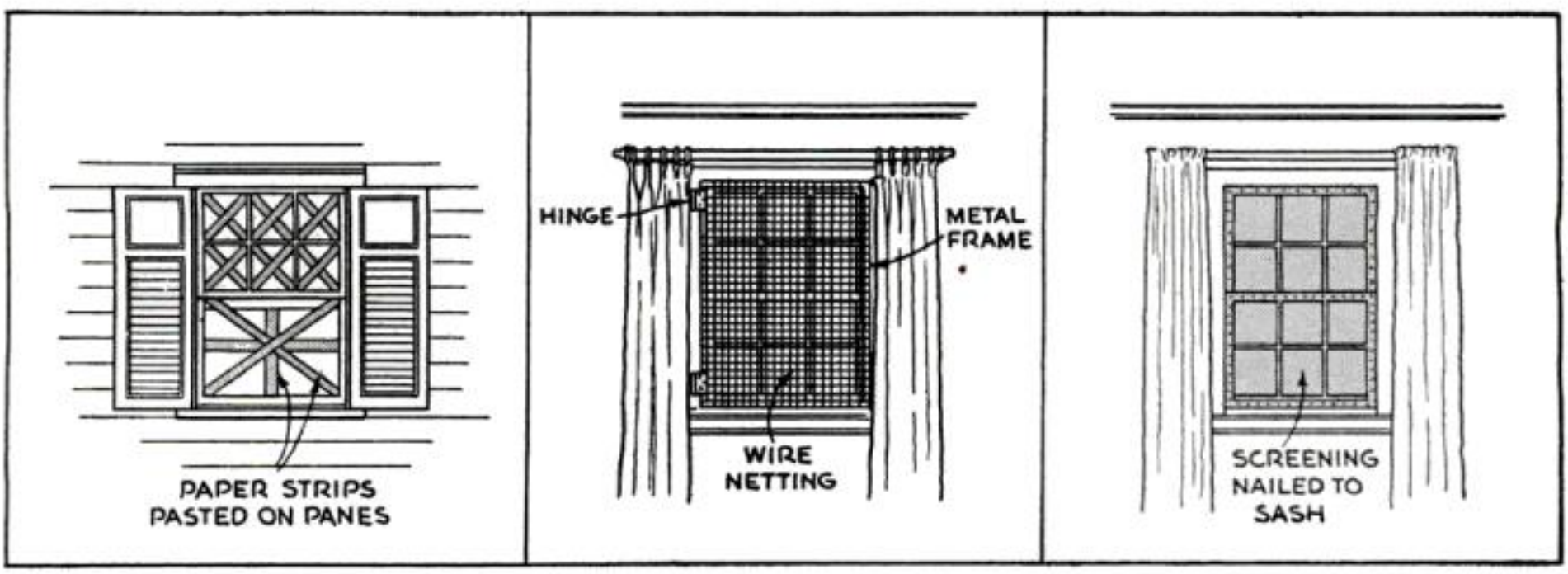
A handy and inexpensive device called a stirrup pump, added to the equipment, will repay its cost many times over if the household water pressure should fail—because of broken water mains, or the drain of all the city's fire-fighting equipment upon the water supply. Preferably, three persons should be ready to handle it—one to guide the nozzle, one to work the double-action pump, and one to bring bucketfuls of water to replenish the supply vessel.

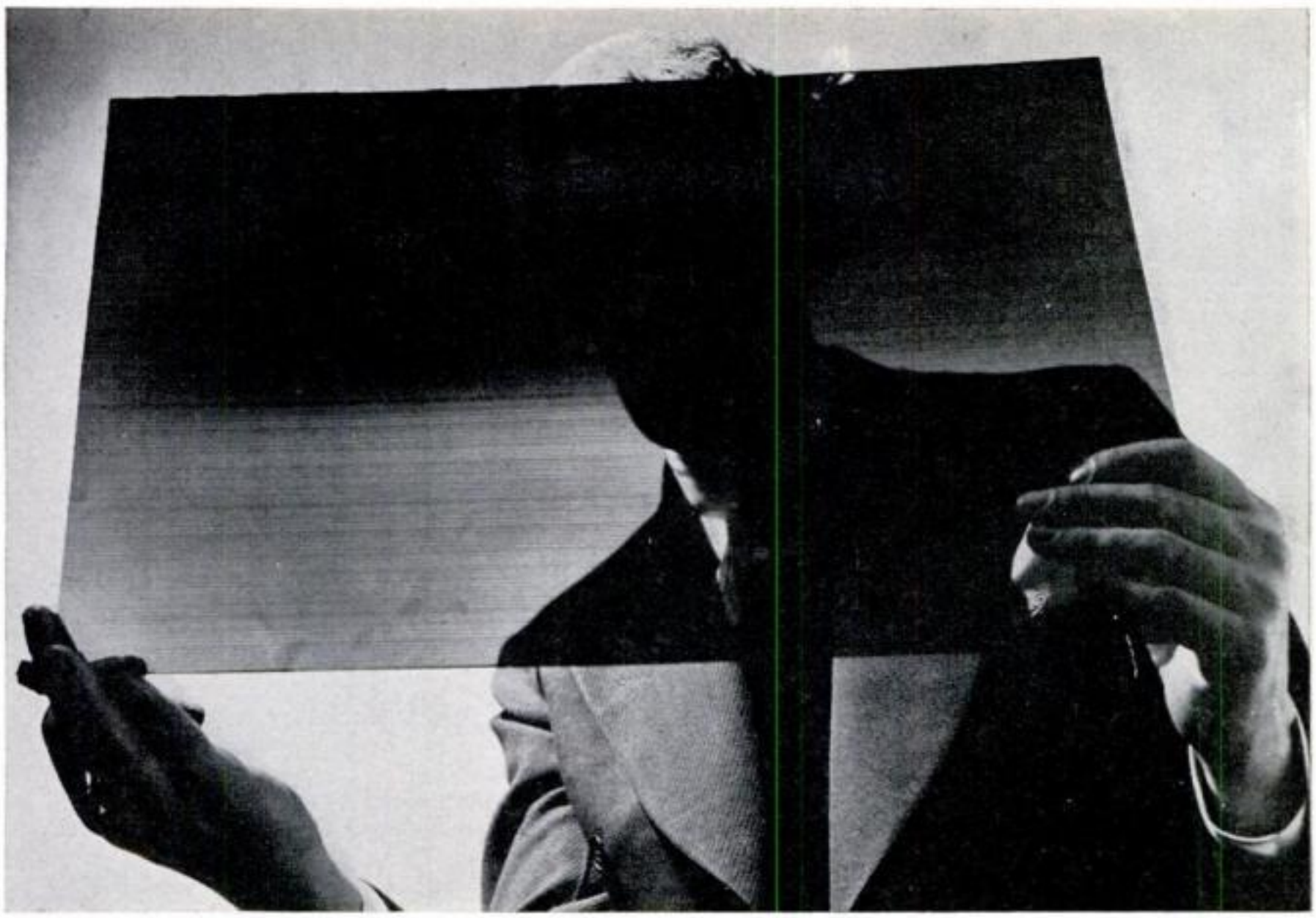
Now the householder is ready for air raiders. As soon as he gets the alarm of their approach—probably by radio, which he should keep tuned in for instructions—he fills the water tubs. Then he keeps an ear cocked to detect the dull crunch that indicates an incendiary bomb has landed.

Fire alarms are telephoned, not to the fire department, but to a civilian fire warden in charge of the district. He will dispatch whatever apparatus is available. In a serious raid, the whole city's equipment may be needed to cope with conflagrations in Army and Navy bases, great munitions plants, vital railway terminals, and waterfront docks. Then the home owner will have to shift for himself as best he can. Immediately he must decide whether to deal first with the bomb or with the fire that it has started. If the fire has made little headway, the first thing to do is to remove the bomb. This procedure is shown in a series of photographs on page 67 of this issue.

Another kind of incendiary bomb employs white phosphorus. This type has a specific antidote which consists of throwing or spraying a solution of copper sulphate on the phosphorus particles. Promptly a chemical reaction coats them with a thin film of metallic copper and puts out the fire. They then may be gathered up in a shovel, taken outside, and destroyed by burning. Every

HOW TO PROTECT WINDOWS FROM BLASTS





This special glass, which becomes opaque when held at 45°, may be used to screen factory windows

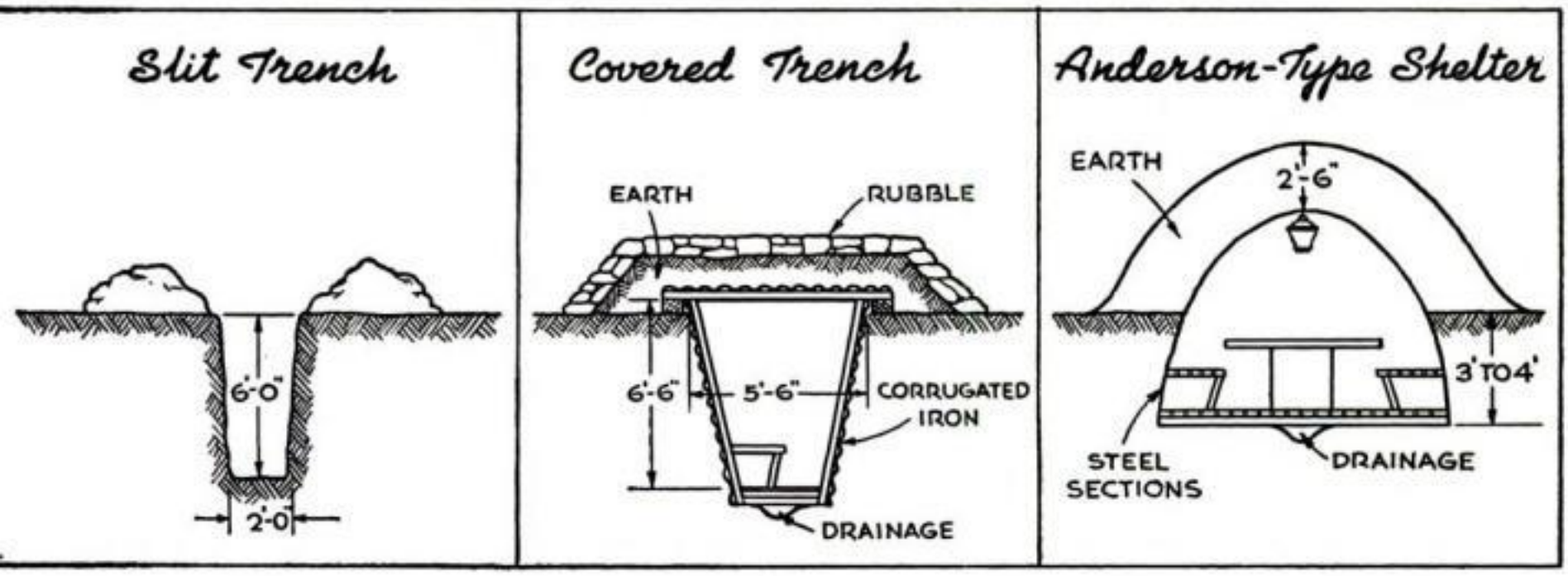
particle must be found, for the fragile copper coating is easily ruptured when struck or stepped on.

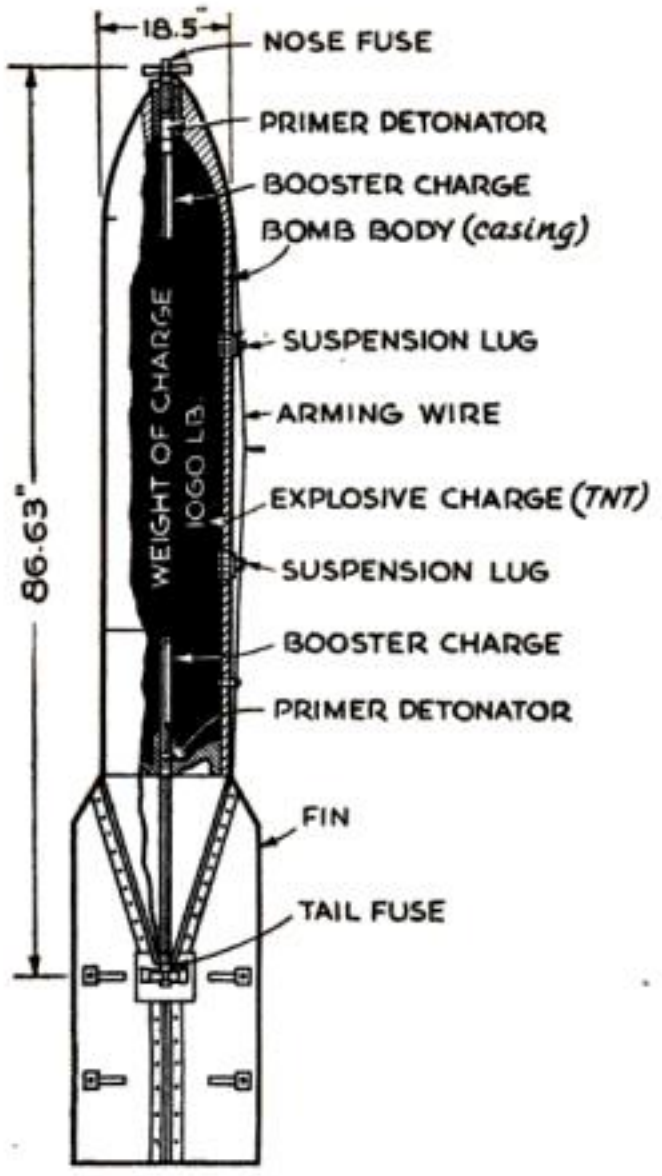
For civilians who are away from home when an air-raid warning sounds, excellent rules have repeatedly been broadcast. Here are some of them with the reasons behind them:

Keep calm. Especially in congested cities, panics are easy to start. They will impede military, police, and fire services. Pay no attention to rumor mongers, or to people who are running and shouting. Fifth columnists have used just such tactics.

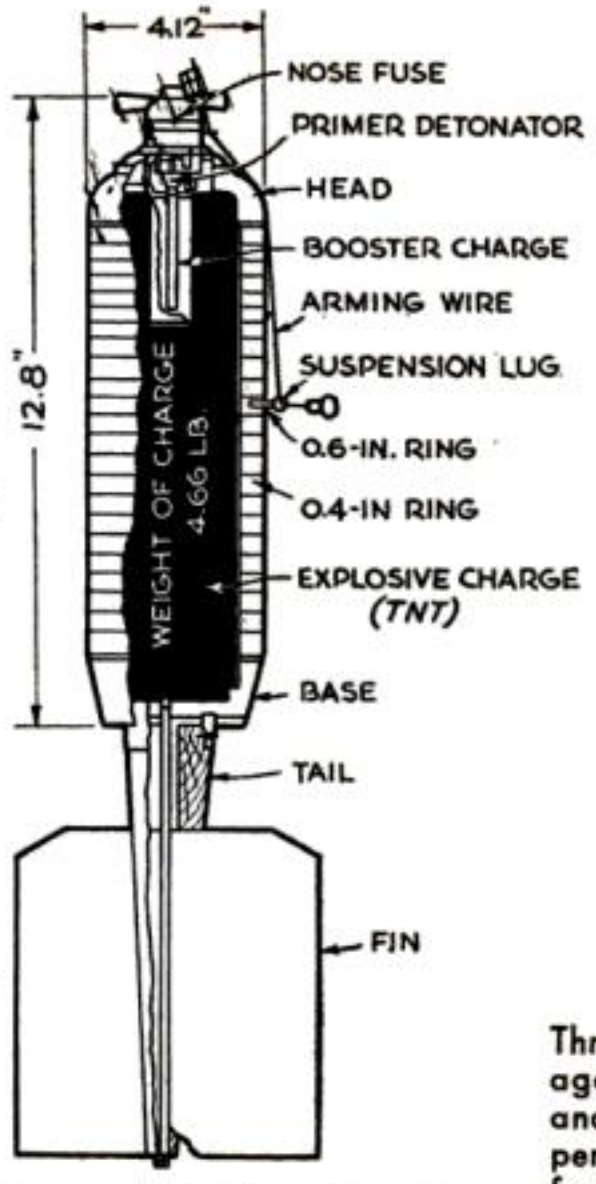
When you hear the warning signal, get off the streets. Walk—don't run. If you are within five minutes of home, go there. Otherwise take shelter, in the nearest building, near the center of a middle floor. Top stories are danger spots in case of direct bomb hits. Ground floor and basement offer risk of exposure to poison gas, which clings to the ground, unless special gasproof shelters are available. Keep away from outside

HOW TO BUILD AN OUTDOOR SHELTER

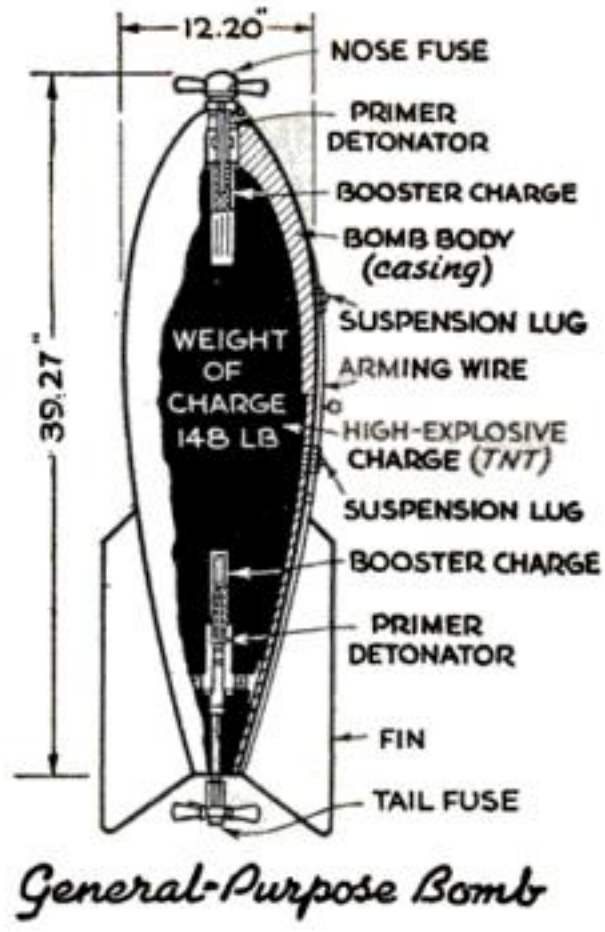




Demolition Bomb



Fragmentation Bomb



General-Purpose Bomb

Three kinds of bombs that might be used against civilian targets. These drawings and the table below are reproduced by permission from the book "Civil Air Defense" by Lt. Col. A. M. Prentiss, U.S.A.

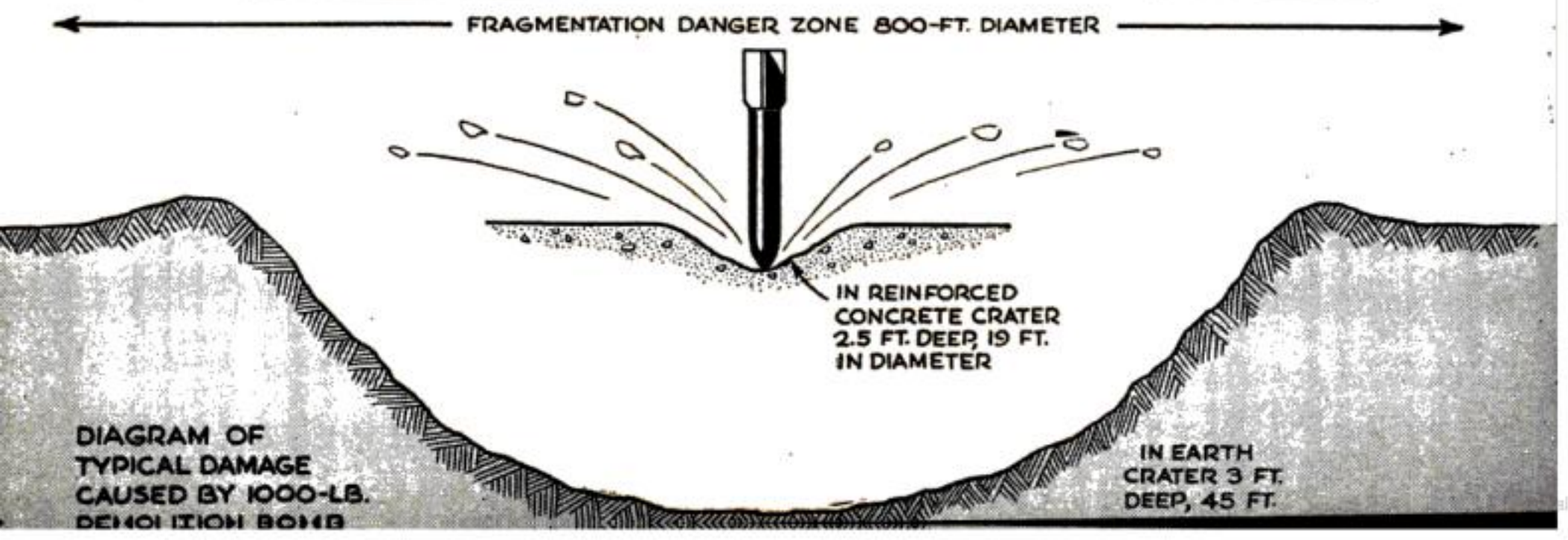
walls, where a bomb blast may send masonry and broken window glass flying; and out of elevators, whose cables may be severed at the top of the shaft.

Subway platforms are unsafe as shelters. British "undergrounds" run deep, but American subways have thin and easily penetrated roofs.

Know where public shelters are, if your city has them. Underground refuges with thick roofs can withstand heavy demolition bombs of high-explosive type. Trenches in public parks offer protection from the flying splinters of smaller, high-explosive fragmentation bombs. Usually the trenches follow a zigzag pattern so that their entire length will not be endangered by a direct hit.

Coöperate fully with policemen and air-raid wardens, whose duty is to protect you and guide you to safety.

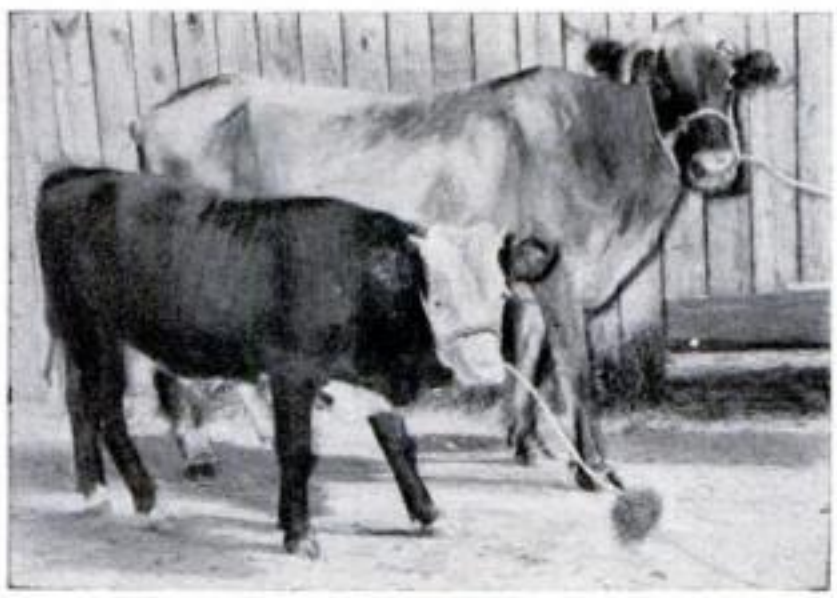
BOMB WEIGHT	SIZE OF CRATER		FRAGMENTATION DANGER ZONE
	REINFORCED CONCRETE	EARTH	
100-LB.	9-IN. DEEP X 3-FT. DIAMETER	5-FT. DEEP X 20-FT. DIAMETER	200-FT. DIAM.
300-LB.	1-FT. DEEP X 4-FT. DIAMETER	7-FT. DEEP X 27-FT. DIAMETER	300-FT. DIAM
600-LB.	2-FT. DEEP X 7-FT. DIAMETER	10-FT. DEEP X 37-FT. DIAMETER	400-FT. DIAM.
2000-LB.	6.5-FT. DEEP X 22-FT. DIAMETER	16-FT. DEEP X 53-FT. DIAMETER	1200-FT. DIAM.



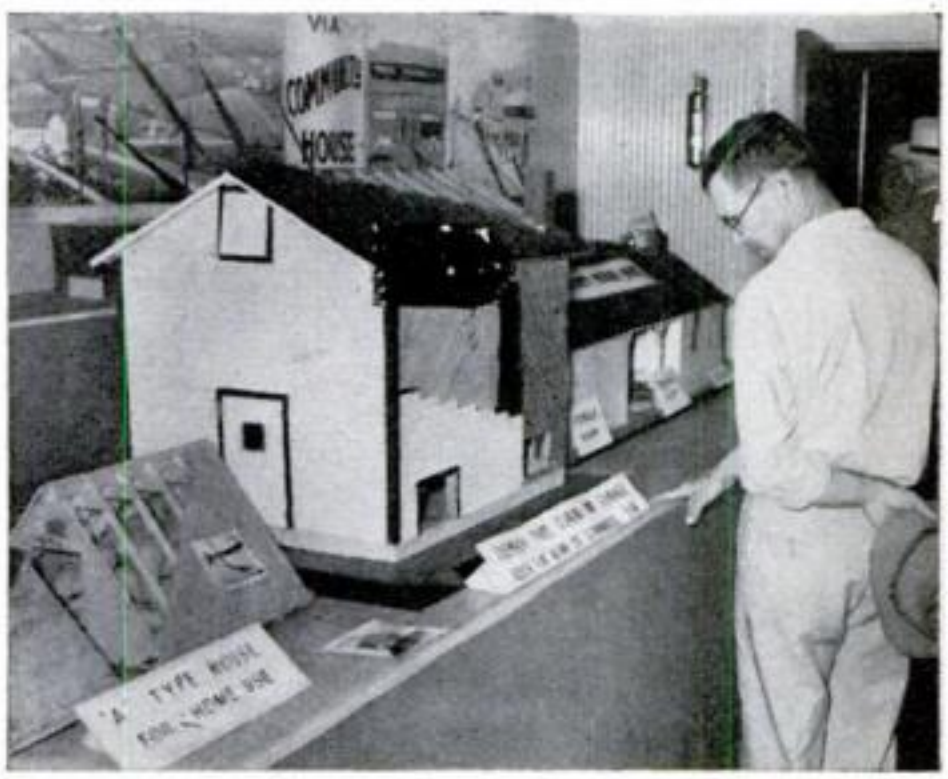
Train Is Converted into Model Farm for Demonstration Tour

BRINGING pure-bred cattle, hogs, and poultry almost into the front yard, the Clemson College Livestock and Better Farm Living Train, an eight-car farm special, toured South Carolina recently, demonstrating the economics of agriculture from a standpoint of national defense to almost 75,000 persons. The train was fitted with model farms, outbuildings, storage houses, irrigation equipment, and exhibits of soil, seeds, forestry, beekeeping, dairying, and beef-cattle breeding.

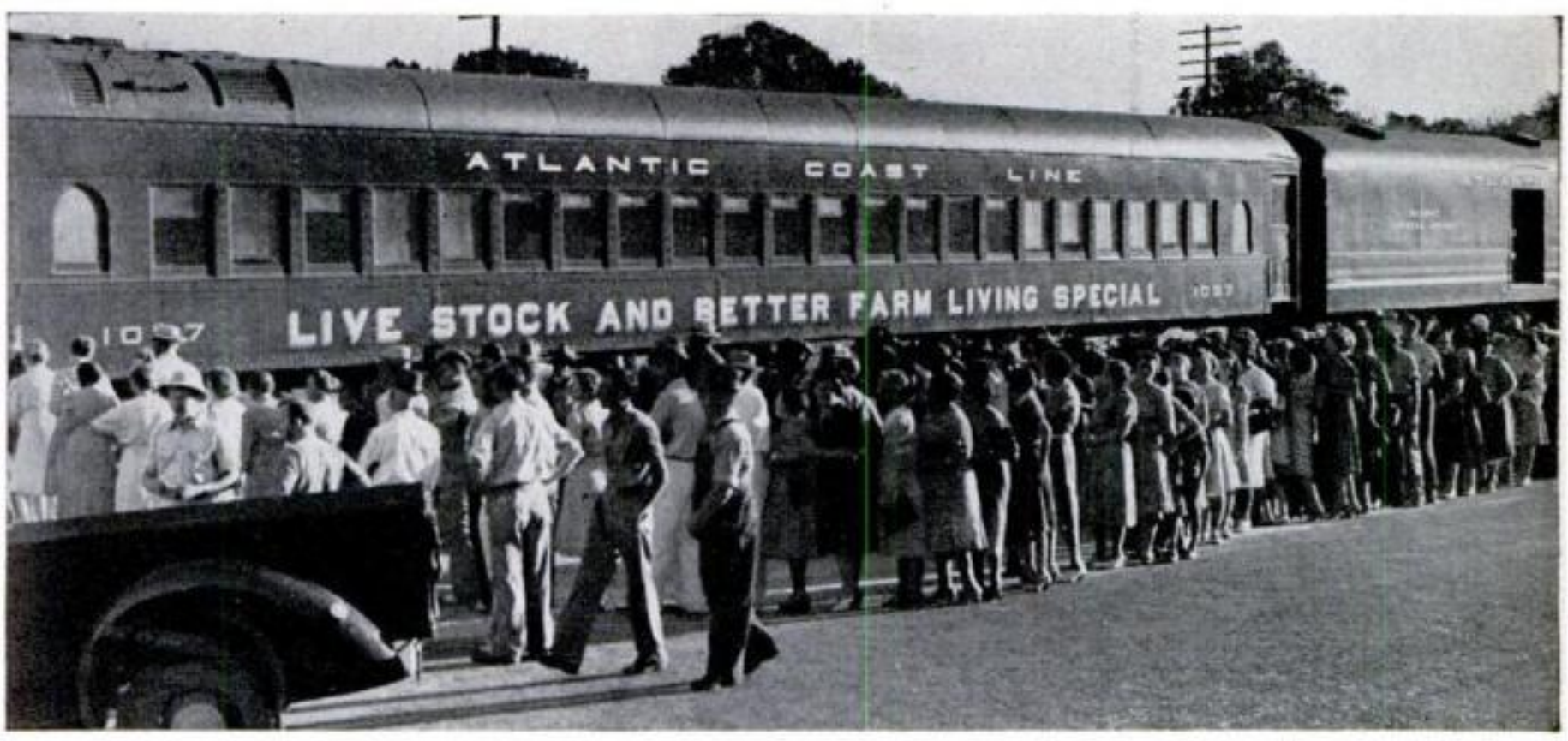
Visitors to the farm train studying a sanitary hog-lot layout and equipment for successful swine production, one of a number of exhibits of scientific farm methods



How cattle can be improved through proper breeding is shown by this common scrub cow and her offspring by a purebred Hereford sire



Models of sweet-potato curing and storage houses give graphic examples of what the modern farmer can do for crop betterment at home or in a community enterprise

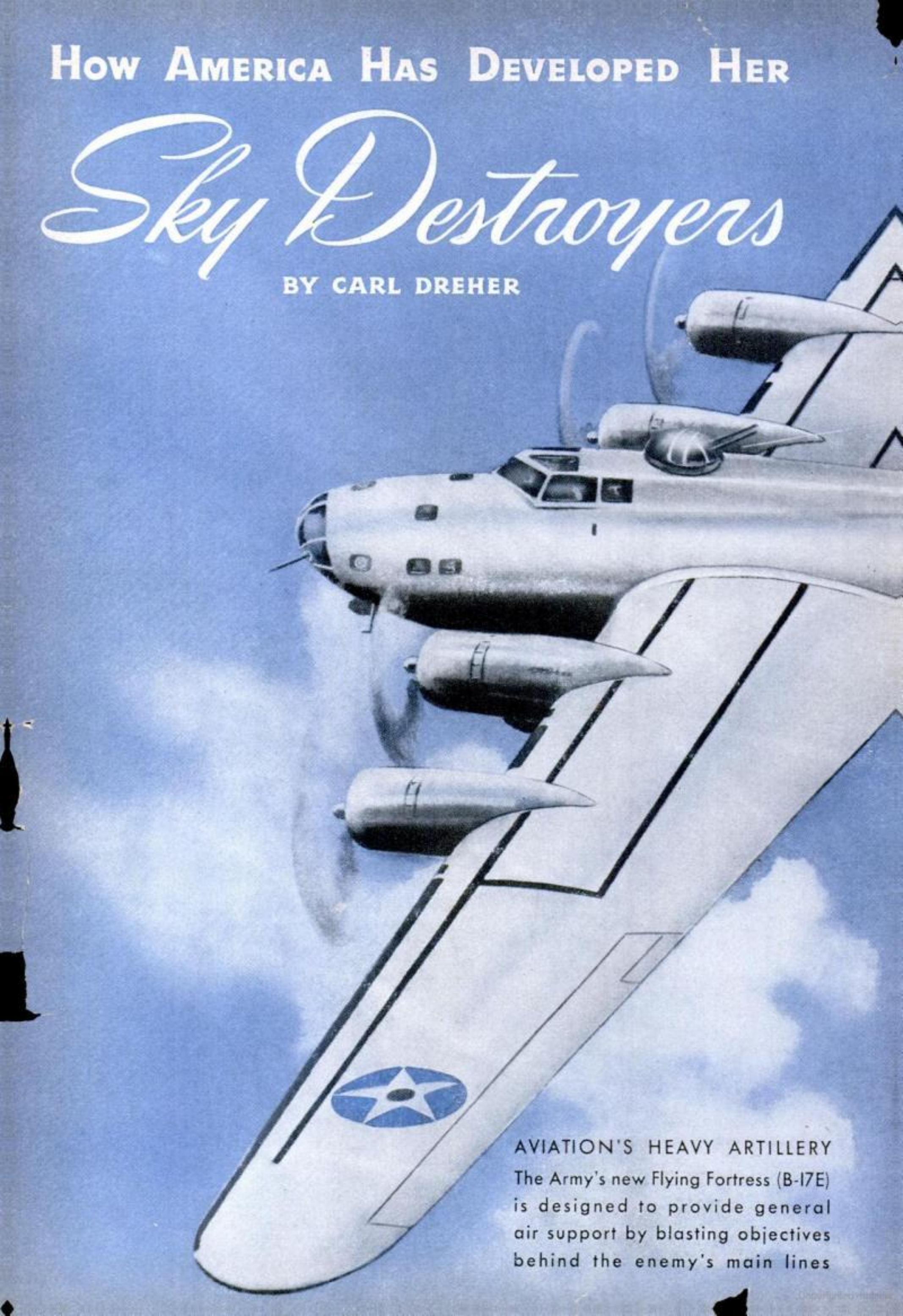


A section of the Better Farm Living Special and the crowd it attracted at one of its 45 scheduled stops

How America Has Developed Her

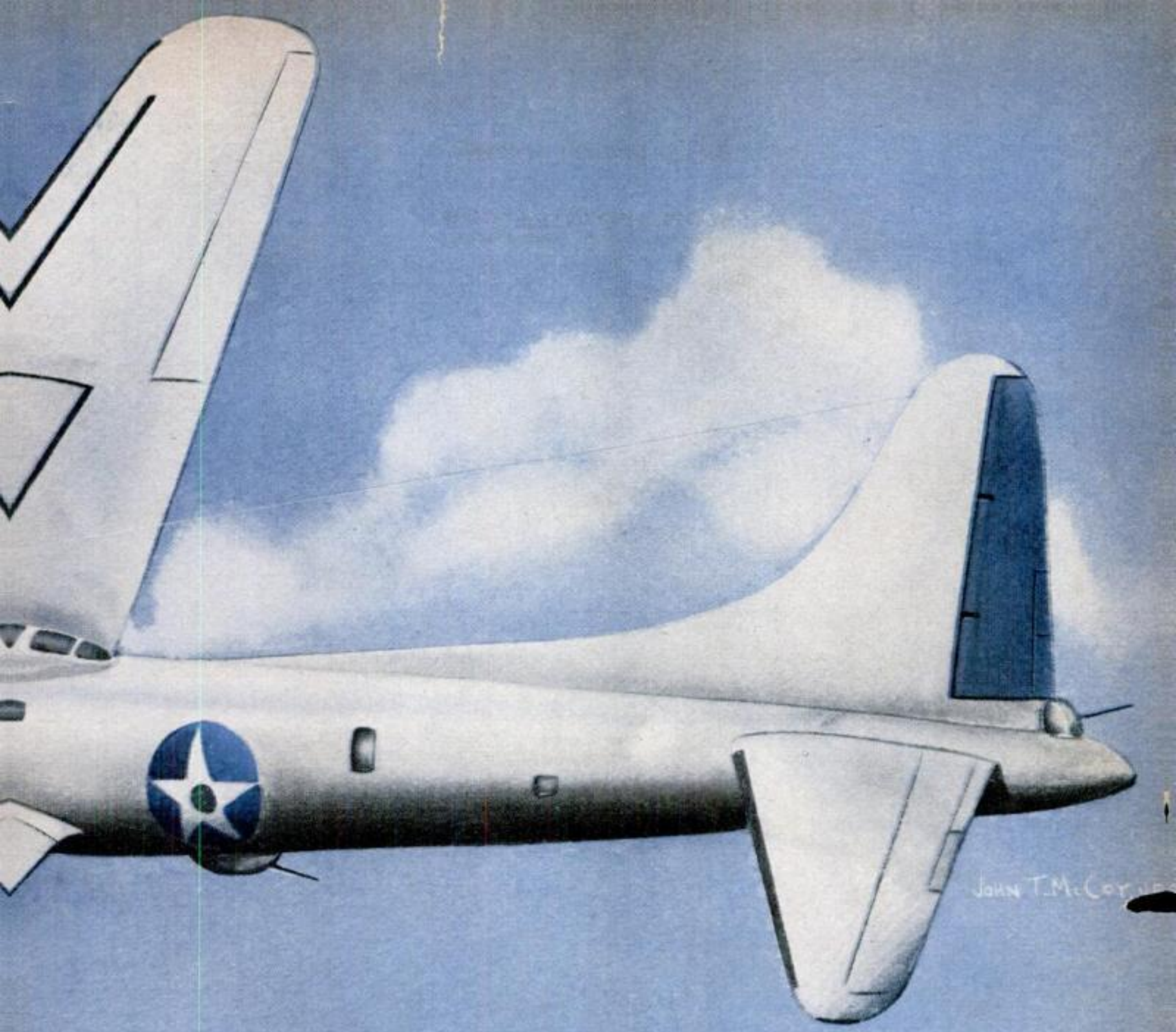
Sky Destroyers

BY CARL DREHER



AVIATION'S HEAVY ARTILLERY

The Army's new Flying Fortress (B-17E) is designed to provide general air support by blasting objectives behind the enemy's main lines



THERE IS NOTHING STATIC about military aviation in any of its phases. It is always doing things in a new way, and almost before one's eyes the new ways become old. But the pace of change is swiftest in that branch least known to the public: air support. It is so new and developing so fast that as yet it has no printed literature. The Army's thoughts about it are set down in 20 mimeographed pages, mostly general theory. The rest is in the heads of the men who are doing it.

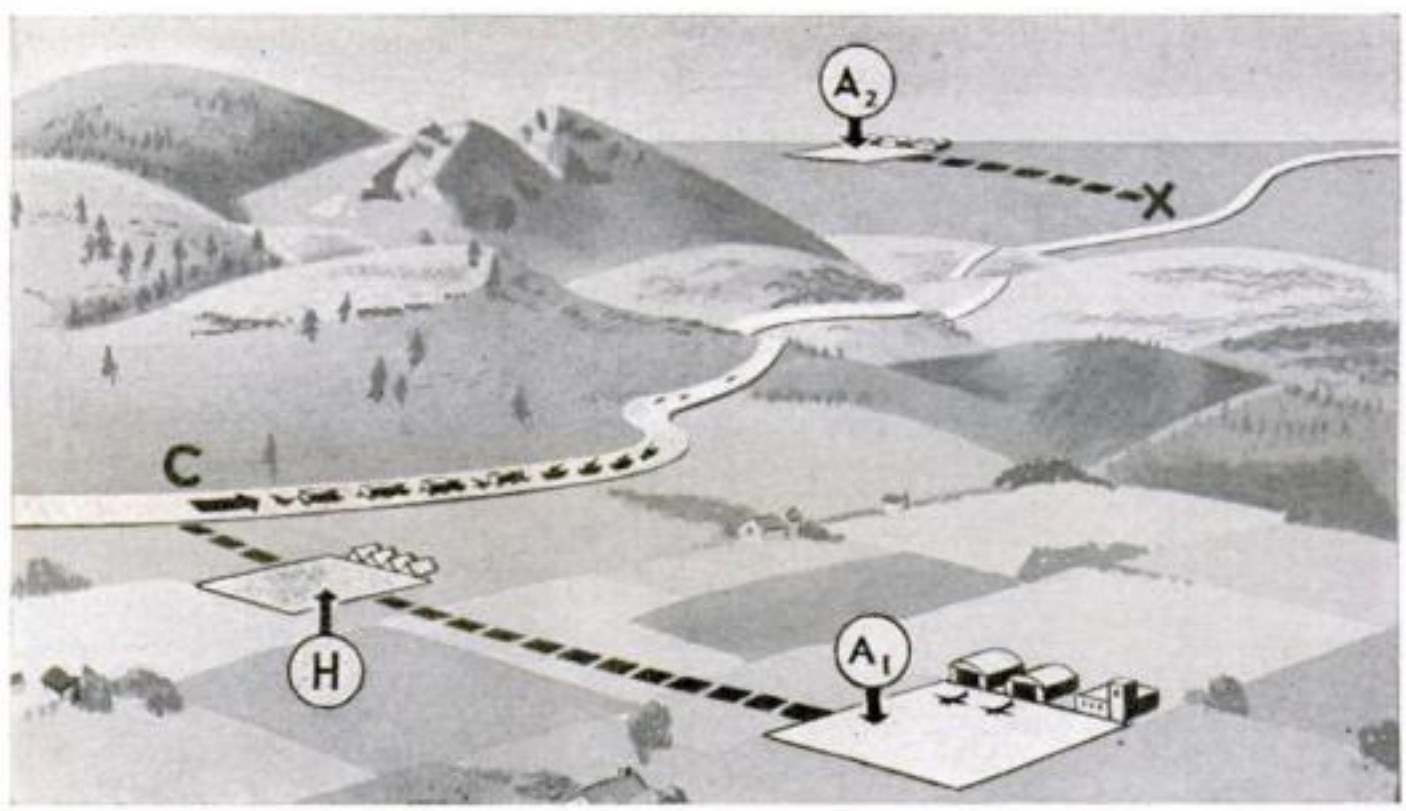
Air support covers all forms of air action undertaken in conjunction with ground operations. The word "support" has a somewhat passive, defensive sound. It is misleading. In actual practice the only way in which the combat flyer can help the ground forces to which he is attached is by attacking the enemy. When the ground troops are stuck and on the defensive, he attacks. When they are advancing, he attacks again. And when he is not sure whether they are coming or going, he still attacks and keeps on attacking as long as he can see anything on which to train his machine guns or drop his bombs.

The support pilot's job contains a minimum of routine and conventional precedent. The long-distance bomber pilot's missions are dangerous and complicated enough, but at least he has a definite objective. His objective folder, with its maps and data, is supposed to contain all he needs to know to get his bombardier above an identifiable target in a fixed location so-and-so many miles away. The interceptor pilot's thinking has to be as fast as the flight of his machine, but he too knows what is expected of him—to bring down bombers which have

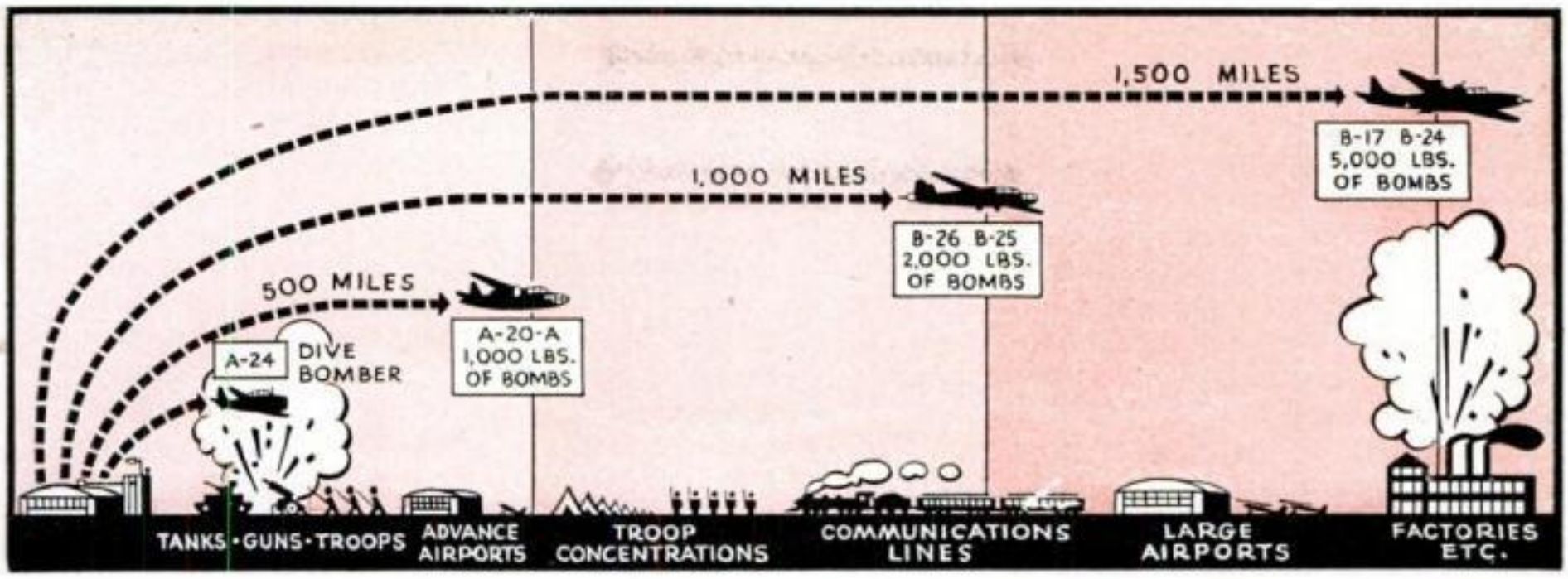
The A-20-A attack bomber often uses grass-cutter tactics to rake enemy concentrations and supply lines

been reported at a given altitude on a given axis of approach. But the support pilot usually lacks even these few certainties of probabilities. As he takes off, he may not know where his target is or what it looks like, or whether there is going to be a target at all. He may not know how far he will fly or how long he will be gone from his home field. He may have specific instructions and be unable to carry them out, and yet his mission may be highly successful. In all these things his situation is quite different from that of other combat flyers. In only one respect are they all alike: none knows whether he will return.

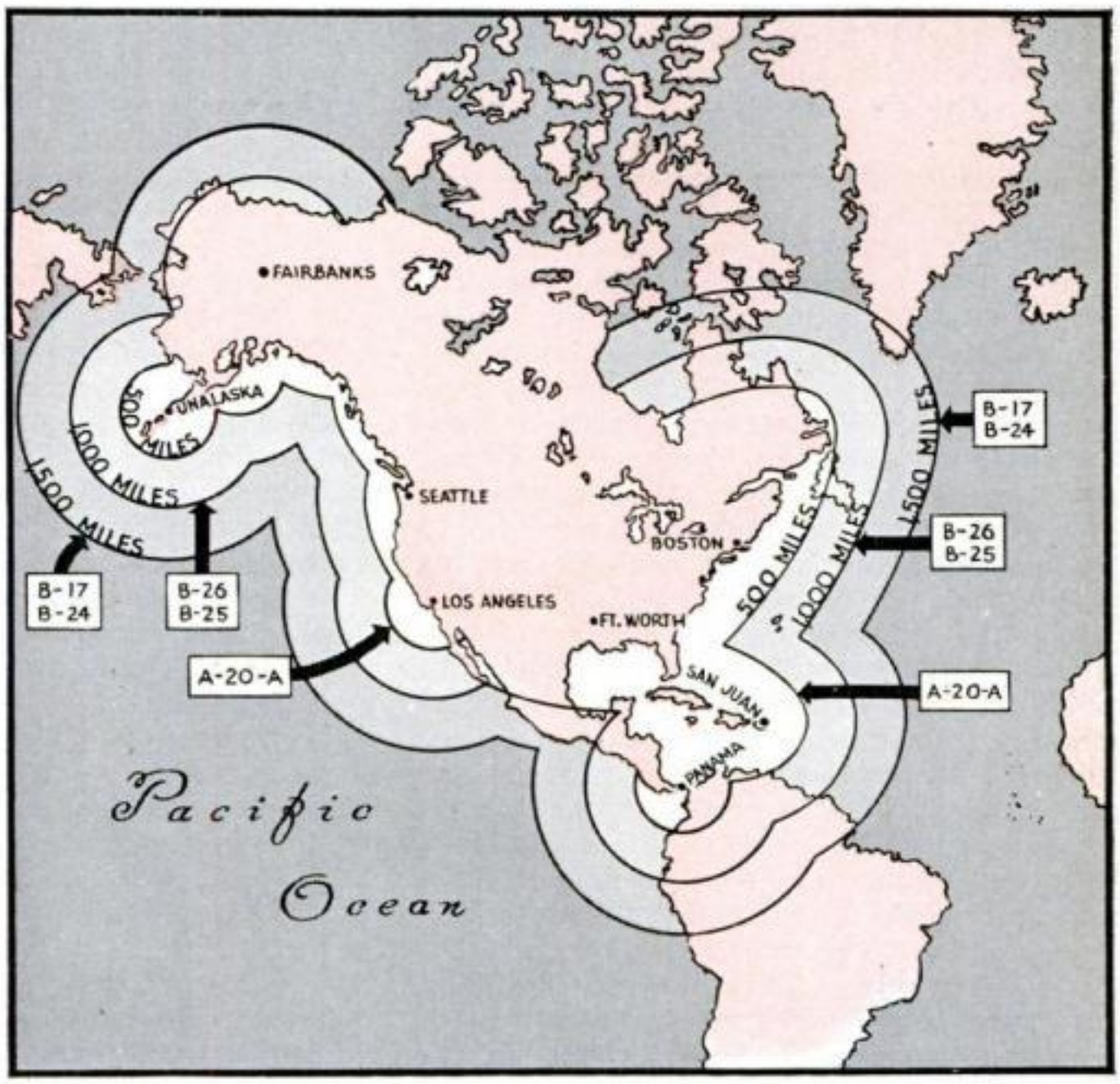
Air support as we now know it—and it will not be the same a year hence—is a natural development from an earlier state of tactical procedure. Let us take a specific situation and see how it would have been handled in the past and how it is handled now. In the diagram below, C is a column, motorized or otherwise, advancing in the direction of a ridge or other natural obstruction. Here opposition is encountered from a screened point X on the other side. The forces at X are unknown. To attempt a frontal assault would be very much like passing near the brow of a hill in an automobile. There may be nothing in the way, or there may be an oncoming truck. It is best not to make the experiment.



Modern air support in action: Instead of sending an observation plane to find out and report on the nature of the opposition at X, the air-support headquarters at H would dispatch a fast reconnaissance bomber with authority to bomb the obstacle if he saw fit



Six types of planes —all bombers—have parts to play in the new use of military aviation. They range from the little A-24 dive bomber to the mammoth B-17 Flying Fortress. What their jobs are is shown in the drawing above



How air support would workagainst an enemy approaching our coast. Concentric circles, spreading out from our Army air bases, represent the areas commanded by bombers of different types, with the B-17 and the B-24. able to strike an invader's supply line 1,500 miles away

Under earlier conditions, the commander at C might have telephoned to the nearest airdrome, A_1. An observation plane would have gone up. When the observer returned C would have got more or less complete information on the strength and disposition of the enemy forces to guide him in his next move. He might then have asked for an attack plane to dislodge the obstructing forces. But whatever action was taken, time had been lost, and while it was being lost X might have been busy to good advantage.

The modern tempo is faster. As soon as serious opposition is encountered, C reports to H, an air-support headquarters in touch with A_1 and all other airdromes in the neighborhood, and with all planes in flight. Instead of an observation plane, a light, fast bomber is dispatched. The crew of this machine can make observations, perhaps not as well as from a slow observation plane; on the other hand they are not as vulnerable to counterattack. But the great advantage of the method is that the reconnaissance bomber, as it is called, can not only get information, but, acting on what the Army calls *air judgment*, do something about it then and there. He may, for example, deposit a few fragmentation bombs on X, and, observing the effects, inform H by radio that the column can now proceed

over the ridge without too much hazard.

Of course this is a schematic and oversimplified picture. X may have his own airdrome, A_2, and C may be the one that is attacked and dispersed. It is a question of who gets there first with the most bombs. But the method is clear. It is an illustration of *close support*—intervention by air on the battlefield. This is one major division of air-support responsibility. The other is *direct support,* which is defined as attack on targets behind the battlefield, to *isolate* the battlefield as far as the enemy is concerned, to prevent him from bringing up reinforcements by attacking his troop concentrations, interrupting his supply lines, destroying his airdromes and planes based thereon, etc. It is a type of bombing intermediate between close support and long-range strategic bombing, but nearer the former.

The fluidity of the support bomber's situation arises from the fact that he operates over a battle front, and that front is something which extends over a wide area and changes by the hour and sometimes by the minute. His targets are where he finds them —*opportunity targets.* He is on his own. Yet free as he is to exercise his independent judgment and in fact compelled to exercise it every minute, he is still a member of a general plan and organization. He is constantly in touch with headquarters by radio. There is no sharp dividing line between the two ends of the radio circuit. Teamwork on the ground means teamwork in the air, and vice versa. At headquarters there is an air-support officer and ground officers—often from both the infantry and the artillery. The location of the control is at or near the ground command post. Here everything can be coördinated, here the staff work is done and the major decisions made. The officer in charge is the quarterback: he calls the plays. The players plunge and twist in their own way, taking advantage of the openings on the spur of the moment. It is this combination of integrated effort and individual initiative that wins battles.

The directing heads are on the ground but many of the decisions are made in the air. When, for example, a reconnaissance pilot blows obstructing forces out of the way, he has in effect made a decision. The mechanized forces on the ground can go straight ahead. When, owing to strong air opposition, antiaircraft fire, or adverse weather conditions, he cannot solve the problem in such summary fashion, he may still be able to facilitate the advance by advising a movement around the hostile units, or some other maneuver suggested by his observations. In any case the decisions on the ground are made largely on the basis of what he sees and does from his moving vantage point above the battlefield.

The diversity of the jobs he is called on to do is almost unlimited. Clearing away impediments to the advance of motorized forces is only one of them. One of his principal missions is to take out antitank guns to facilitate the advance of our own tank attacks. One of the most important lessons learned from study of the German air-ground combat-team action is the technique used by the Stukas in destroying antitank guns to prepare the way for tank advances. After a break-through the support bomber protects the flanks of the penetrating forces. He is active in covering parachute troops and air infantry during transit and landing, and in preventing the enemy from bringing up an overwhelming force to wipe out such detachments after they have seized a strategic position. The tendency is to extend the operational field of support aviation both in a geographical and a functional sense—to assign new missions to the support groups and let them range farther afield in performing new and old missions.

Aside from the training, experience, and enterprise of personnel, the factors which make for success in support aviation are offensive weapons, including airplanes and their armament; communications and control, and strategic location of airdromes. The last is not the least important. In general it is desirable to base support aircraft close to the fighting front, so that planes can be in action in the least possible time after taking off. This makes the rapid construction of forward or advanced airdromes a prime necessity. New, specialized organizations are being developed for this purpose by the Corps of Engineers. Two battalions of specially trained engineers, comprising a force of 1,000 to 1,200 men, can in about two weeks clear and grade an emergency field large enough to accommodate all types of military planes. Many such fields are required, because, quickly as they are built, they are even more quickly damaged. Forward airports, and the planes based on them, are of course a favorite target for enemy bombers, and around each principal field there must be auxiliary fields for dispersal of aircraft, so that when an attack comes there will not be too many eggs in any one basket.

An advance airport comprises a great deal more than a flat, hard surface. Unless it is to be used only as an emergency landing spot, it requires gasoline stores, a power supply, some repair facilities, and shelter for personnel. The Army has repair trucks for aircraft, carrying all necessary hand tools and even light machine tools, and re-

The B-25 medium bomber. With the B-26, a ship of similar range and general characteristics, it shares the work of attacking military objectives up to 1,000 miles from its base. Carries 2,000 pounds of bombs

Climbing into their plane for a flight, the seven men of the crew of a B-25 divide up into two parties. Pilot, copilot, navigator, and bombardier crawl into the front end, while the flight engineer, radioman, and gunner enter the tail section

cently flying repair shops have been added. These are transport planes equipped with tools for emergency repairs to enable a damaged ship to be flown back to a repair depot. Another auxiliary service that cannot be dispensed with at the front is aviation weather forecasting. When urgent need arises, military flyers are willing to go up in any kind of weather that by some stretch of the imagination can be termed flyable, but the least the ground forces can do is to keep them informed on what they are going to encounter. Accordingly, where tactical units go the mobile weather units must go, to make local observations and maintain contact with the weather stations in the rear by teletype and radio. Ease of communication is likewise vital to support aviation: without an efficient communication service there can be no effective coordination between units. Visual signaling is used to some extent for communication with airplanes flying in close support. But the principal contact between air and ground is of course by radio, both voice and telegraph. Since, flying near and over enemy positions, the operators must expect their messages to be monitored by hostile stations, simple secrecy codes are devised to designate targets, time of attack, number of planes, and the like; and these codes are re-keyed as often as necessary. *(Continued)*

Air counterpart of light field artillery is the dive bomber, represented in the U.S. Army by the A-24. Accuracy and maneuverability make it the preferred weapon in close support of ground forces

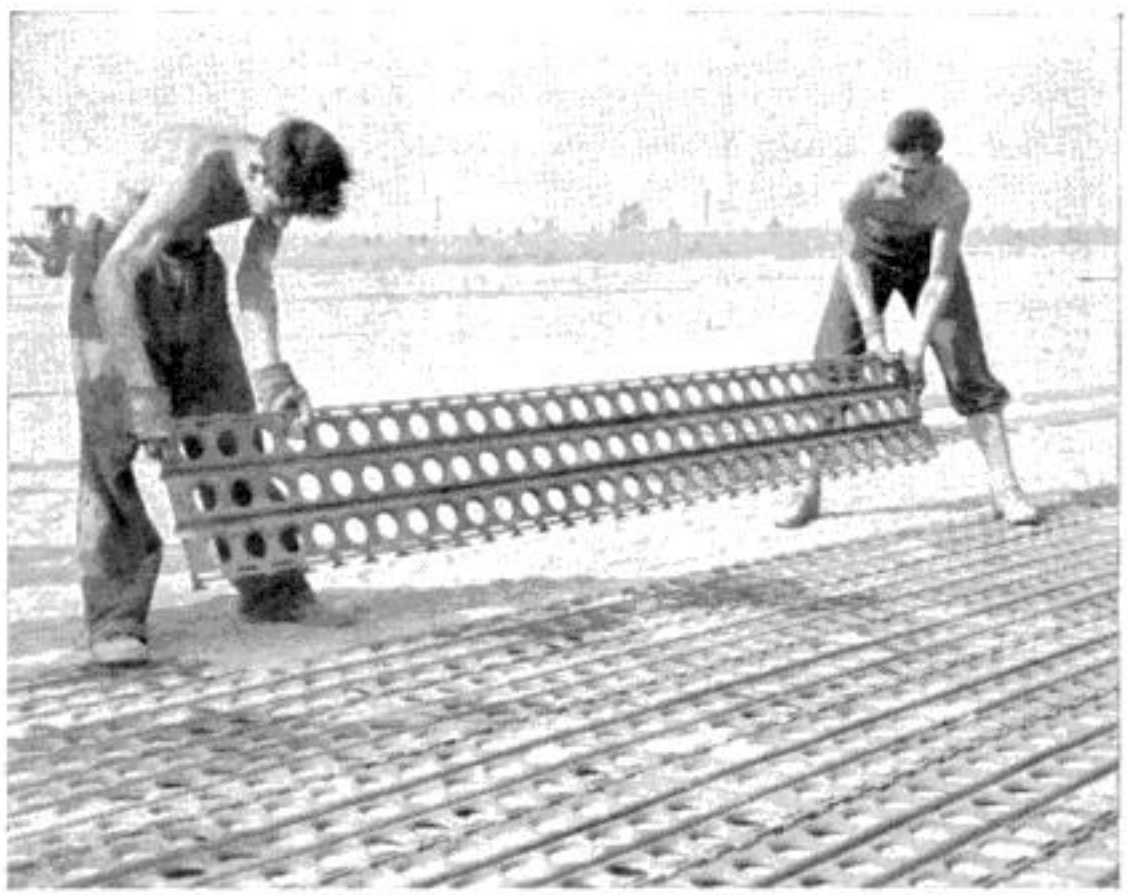
The planes most frequently used in support of ground forces are the A-24 dive bomber and the A-20-A, a fast, short-range two-engined bomber. (The A-20-A's were one of the features of the recent maneuvers in the damage they inflicted on the Red and Blue armies.) The more powerful medium bombers of the B-25 and B-26 types also are used in support, but for the most part it is a light bombardment job and smaller bombers fill the bill. For close support the dive bomber is preferred. European experience indicates that its reign as an instrument of terror is already over. The French may have been stunned by the German dive bombers; the Russians were not, and shot down great numbers in the fall of 1941. But, regarded as just another weapon, indicated in some situations and contra-indicated in others, it has its place. Its accuracy and maneuverability fit it for use against precision targets and what the Army poetically calls "fleeting targets of opportunity." Most free-lance bombing in close support is of this character. The targets may be troop concentrations or movements, minor field fortifications such as pillboxes, motorized columns, artillery in position or in motion, etc. The effectiveness of the attack depends on speed and surprise. The pilot takes off, sees what he is after, and dives at it. The usual height at the beginning of the dive is around 8,000 feet. A descent of about 4,000 feet is usually required for the 70-degree angle favored in this kind of operation. At an altitude between 3,000 and 4,000 feet the bombs are released. The plane levels off at 1,500 feet and zooms away.

In direct support horizontal bombing is preferred. The A-20-A affords greater bomb-loading than diving aircraft and has the additional advantage of high speed in horizontal flight. The prey of the A-20-A is lines of communication, airdromes and aircraft on the ground, bomb dumps, troop concentrations, command posts, and the like. Most of the work is done at low altitudes. The attack bomber is necessarily a grass-cutter at times; he is not reckless, but he works at the most effective altitude, whatever that may be. At very low levels he relies on great speed relative to the target and its defenders for protection. By flying close to the ground and taking advantage of the cover of trees and hills he can often surprise his objective, and be off before ground crews can aim their guns.

The conventional weapons of the attack bomber are the machine gun and the bomb, and the bomb is the more important. The big bombs used in long-range strategic bombing are not suited for support aviation. In this field multiple assaults with comparatively light bombs are most effective. As far as possible, loading is limited to a very few types. Against fortifications demolition bombs weighing between 50 and 250 pounds are standard. Demolition bombs operate by concussive pressure or blast, consequently almost half the weight consists of TNT. Against personnel, fragmentation bombs are used. These usually come in 30 and 100-pound sizes, and they differ from demolition bombs in that most of the weight is in the metal case. An ordinary fragmentation bomb contains less than five pounds of TNT. Such bombs will damage light material targets, such as airplanes on the ground, but their primary purpose is to kill. Machine guns of .30 and .50 caliber are similarly used against ground troops, and also afford protection against hostile aviation.

A new factor in close-support operations is the growing conviction that the light bomb is not the weapon to destroy tanks. The problem of attacking tanks from the air has not been solved—in fact, until some better method is devised, there is the feeling that tanks must be hit by air-borne cannon, such as the 37-mm. carried by the P-39, a pursuit ship. The success of these guns

Air support calls for bases near the fast-moving fighting line. Here soldiers are laying metal mats that form a portable runway developed by the Army Engineers for short-order landing fields



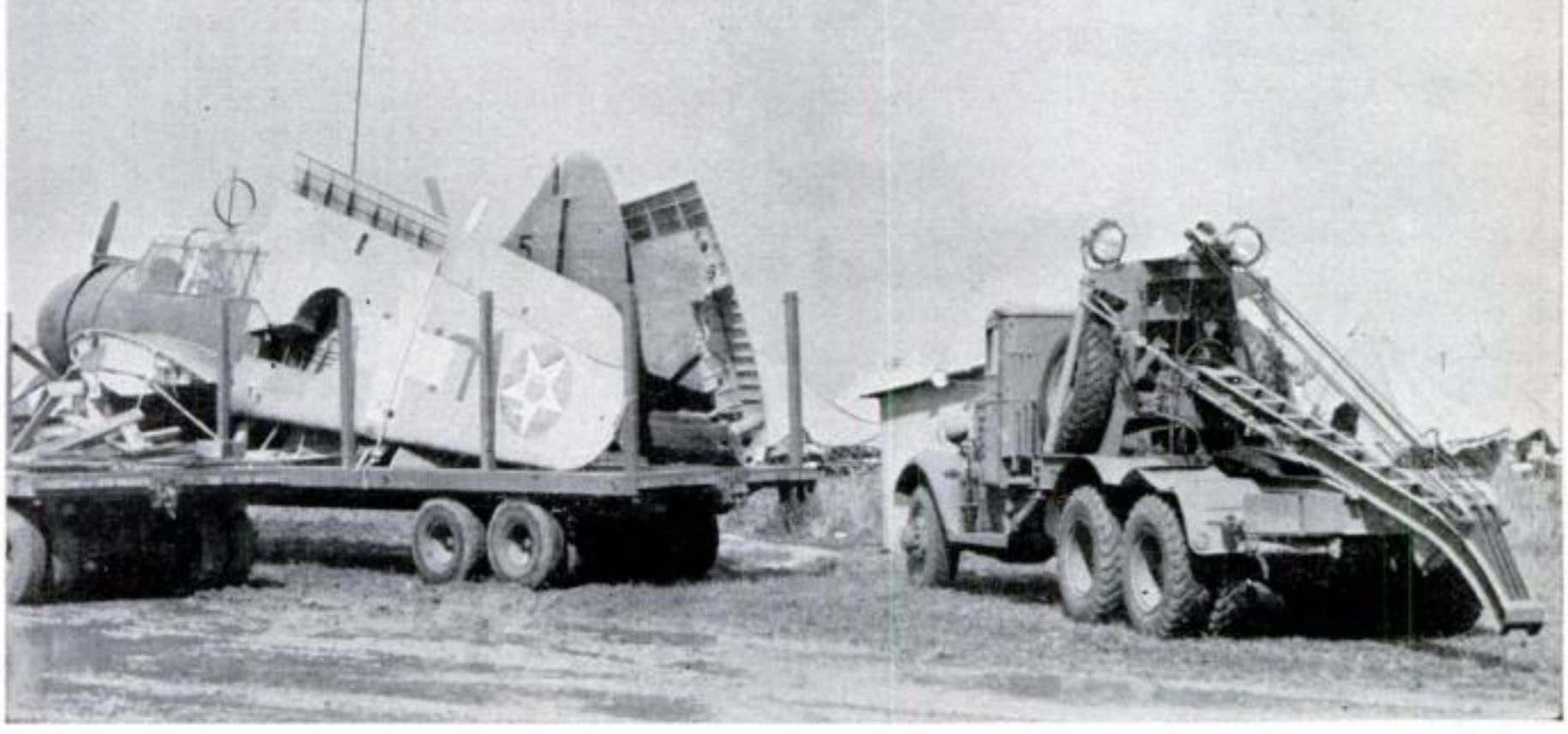
in antitank operations from the air during the recent Army maneuvers suggests the possibility of their eventual use on the light bombers.

These are the weapons. Their tactical use is something that cannot be blueprinted. All military operations, as planned in advance, are in a sense a preparation for the unexpected. Yet there are some fairly well-defined rules for the most effective use of support aviation. These relate mainly to the optimum number of planes for a given operation. Against precision targets and in close support the single airplane is most adaptable and gives the best results. It is likewise effective against linear targets, such as marching or motorized columns, but usually such objectives are important enough to warrant the use of small formations—loose three or four-plane elements. Such columns are very inviting targets for support bombers. The attacking units approach obliquely, turn, and fly over the objective only during actual delivery of offensive fire. The conventional method is for the leading plane to line up the target with the gun sight, nose down and deliver forward machine-gun fire, level off, and release bomb loading. The following planes repeat this procedure on other portions of the column. Usually a single pass is sufficient to obtain effective hits. When defensive fire is heavy it is inadvisable to make more than one pass; the defenders are apt to be more accurate in their aim the second time around.

Larger formations, up to squadron size (12 to 15 planes) may be used against area targets. A squadron is about as much as one commander can handle in the air, and the target has to be worth while to warrant so much risk and expenditure of material. In these cases a bombing pattern is worked out in advance, with each plane in the squadron assigned to a specific portion of the area. The altitude is likely to be comparatively high and the bombsight is necessary for accurate aim.

If, in accordance with present plans, we are to have an air force of 500,000 men, the support groups will have to be a great deal larger than they are now. The present air support is good—what there is of it. Training additional personnel will be a considerable job in itself. The problem is one of *joint* training. Air-support fliers must have at least a fair understanding of ground-force operations and dispositions, besides the technique of air attack, communication, map and photograph reading, and all the other subjects with which they must be familiar. The ground forces, for their part, must learn the potentialities and limitations of combat aviation, ground reconnaissance with a view to selecting targets for aviation, signaling to aircraft, and so on. Above all, once the elementary stages have been passed, there must be joint training in maneuvers. The soldier, like other men, learns mainly by practicing what he has been taught. The frequent use of ground officers as observers from aircraft, and of air officers as observers with ground forces, is vital to progress in this field. And that progress is vital to the Army.

Repair facilities, too, must keep pace with the shifting tide of battle. Mobile machine shops and cranes help to keep the maximum number of planes in the air at all times. Latest development is the flying repair shop, a transport plane equipped with tools to mend a crippled plane so it can fly back to a base



HOW IT IS DONE

America Takes Over an Ancient Art . . . RUBY CUTTING

SKILLED HANDS UNCOVER BEAUTY OF GEMS THAT ARE MORE PRECIOUS THAN DIAMONDS

CONTRARY to popular belief, rubies, not diamonds, are the most precious of all jewels. And today, fashion, taste, and fortune have made Americans the world's best customers for rubies while the war has made the United States the greatest Western cutting center for them.

Once, American gem dealers and shrewd Hindu merchants traveled from opposite sides of the world to meet in Paris and London. Now, because the Paris precious-stone market is completely closed down and the London trade is sadly dislocated, direct contact has been established between them via the mails, cables, and radio. American imports have grown so large that rubies, formerly classified in the customs reports under "other precious and semi-precious stones" this year will be separately classified with their sister stones, sapphires; while their price in the rough has soared 15 to 20 percent and the wages of ruby cutters have jumped 50 percent.

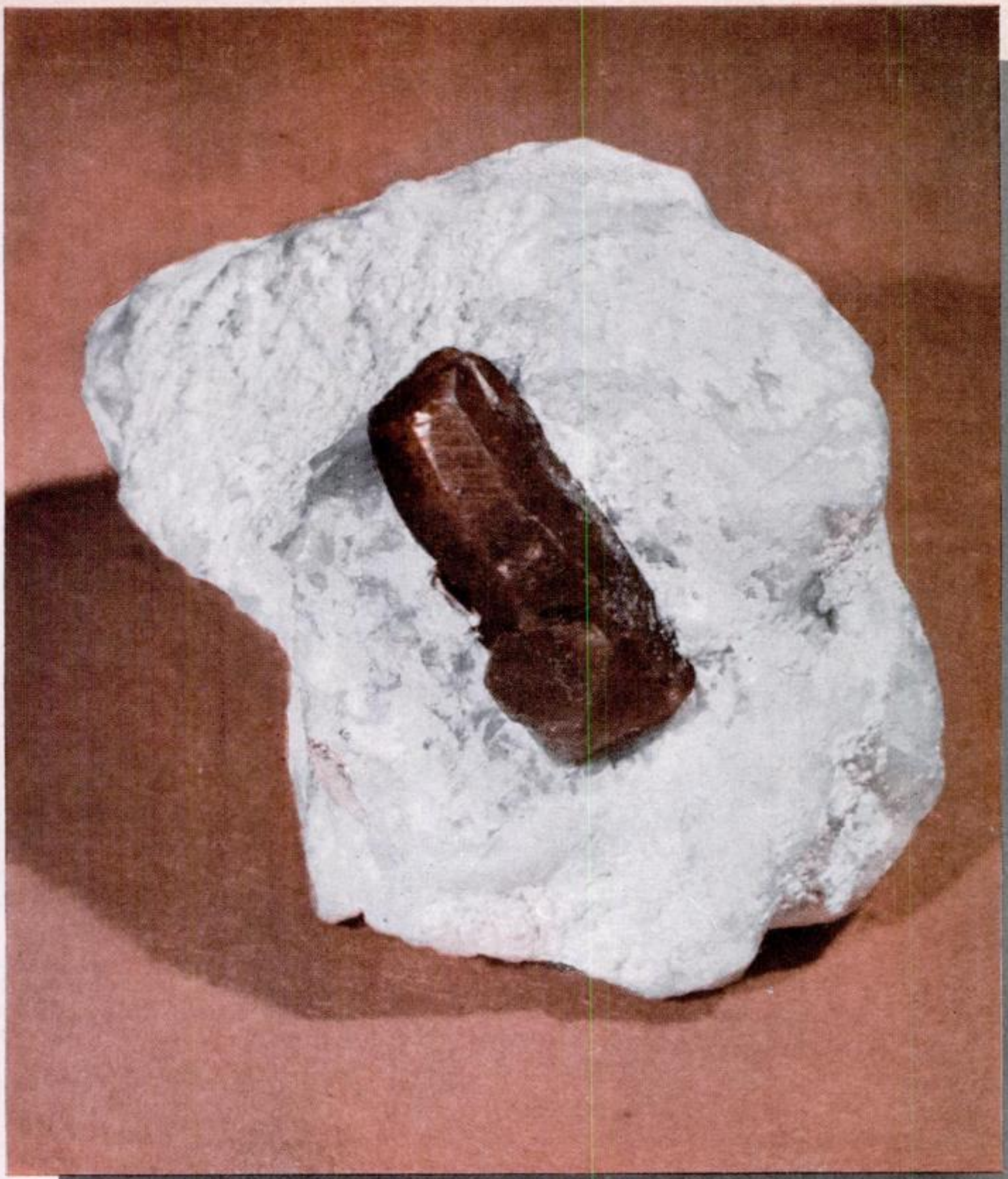
Rubies over four carats (about 1/34 of an ounce) are the rarest of all jewels and command higher prices than any other gem known; $1,500 a carat is not unusual, although a really large, fine specimen may be a bargain at $15,000 the carat. Always the color of the stone and its freedom from flaws are more important than its size, but, if of good quality, the larger it is the more costly per carat.

Scientifically a ruby consists of nothing more than aluminum, oxygen, and a trace of chromium. Like its precious twin, the sapphire, it is a color variety of the common mineral corundum, and corundum is simply a six-sided crystallization of aluminum oxide. Colorless in its pure form, but usually gray or brown or greenish black, it is seldom found as a transparent gem and even more rarely in its red color. This glowing red of the ruby is due to an impurity in the alumina, a trace (one or two percent) of chromium oxide. The hardest substance found in nature except the diamond and tough (resistant to sharp blows) as well, the ruby has all the qualifications for a perfect jewel: durability, beauty, and rarity.

This hardness and toughness have given it still another importance. Since it will cut almost anything else but a diamond and is not distorted by pressure, it has long been used industrially: as an abrasive in the cutting of other stones, such as jade; for certain drills; and as bearings in watches, ammeters, and other delicate mechanisms.

A degree less scarce than turkey molars, rubies are found in but few spots on the surface of the earth. Occasional finds have been made in Afghanistan, Australia, India, Madagascar, and at Cowee Creek in our own North Carolina. These, however, are seldom of any value, and the true sources of the gem are Burma, Siam, and Ceylon. It is the ancient mines near Mogok in Burma that yield the gem of gems, the almost legendary "pigeon's-blood" ruby, of a purplish red shade. Next in rank are the dark-red and red-brown products of Siam, and least valuable—for rubies—are the pale, brilliant type found in Ceylon. Occasionally star formations, called asterisms, appear in milky or cloudy rubies. This star-shaped radiance that glows from the interior of the stone when it is cut in the form of a dome, is the result of light reflected from a tiny system of hollow tubes running at right angles to its axis. Usually six-rayed because ruby crystallization is six-sided, these stars have a special beauty.

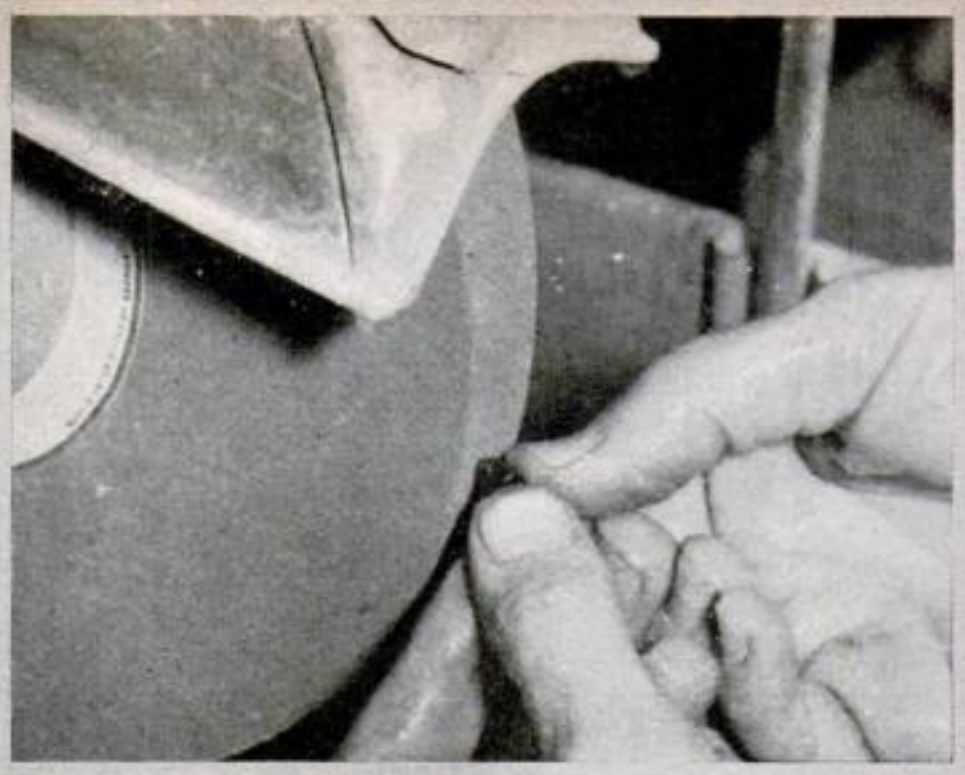
Throughout history the ruby mines of Burma have been one of the world's greatest sources of wealth. Yet, curiously, the ownership of a mine is not often very profitable. Even in the fabulous region near Mogok, the stones found average only one fourth of a carat in the rough; only a fraction of one percent are of gem quality; and,



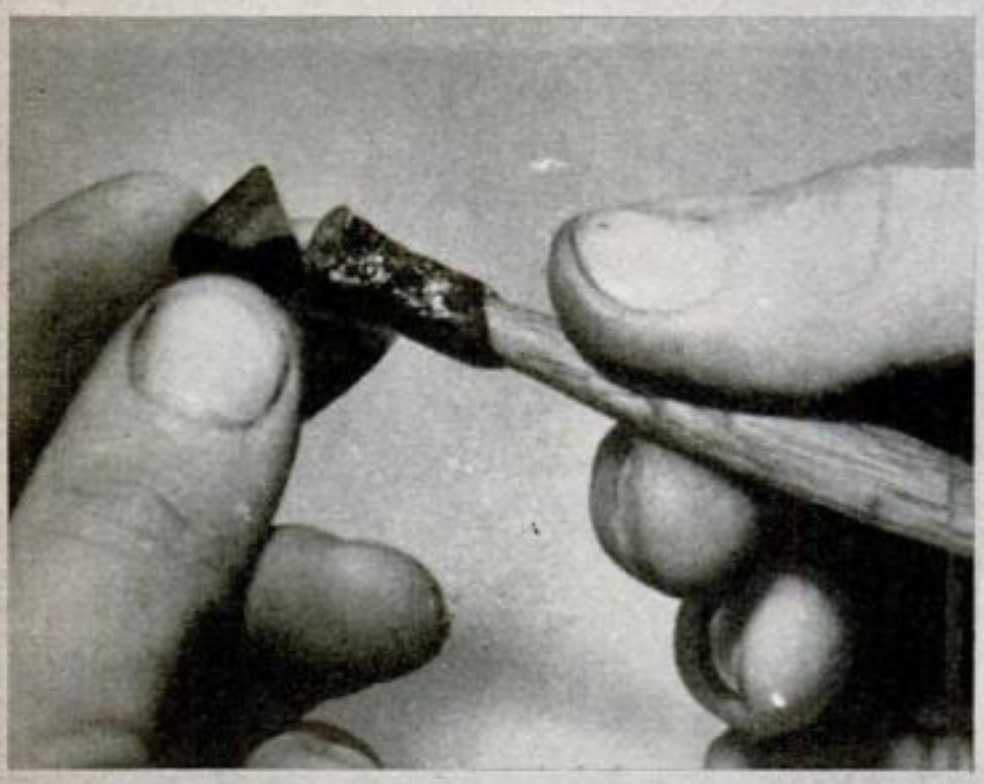
A Burmese ruby in the matrix in which it was found. All its angles and facets are natural. How rubies are cut for jewels is shown on the following pages →

Photo by Charles Coles, American Museum of Natural History

1 Ruby cutting, whether practiced in India or in New York, employs methods that have changed little for centuries. This is a stone as it comes from the mine



2 The first operation is rough grinding. This is performed by holding the stone with the fingers against an abrasive wheel to remove outer roughness

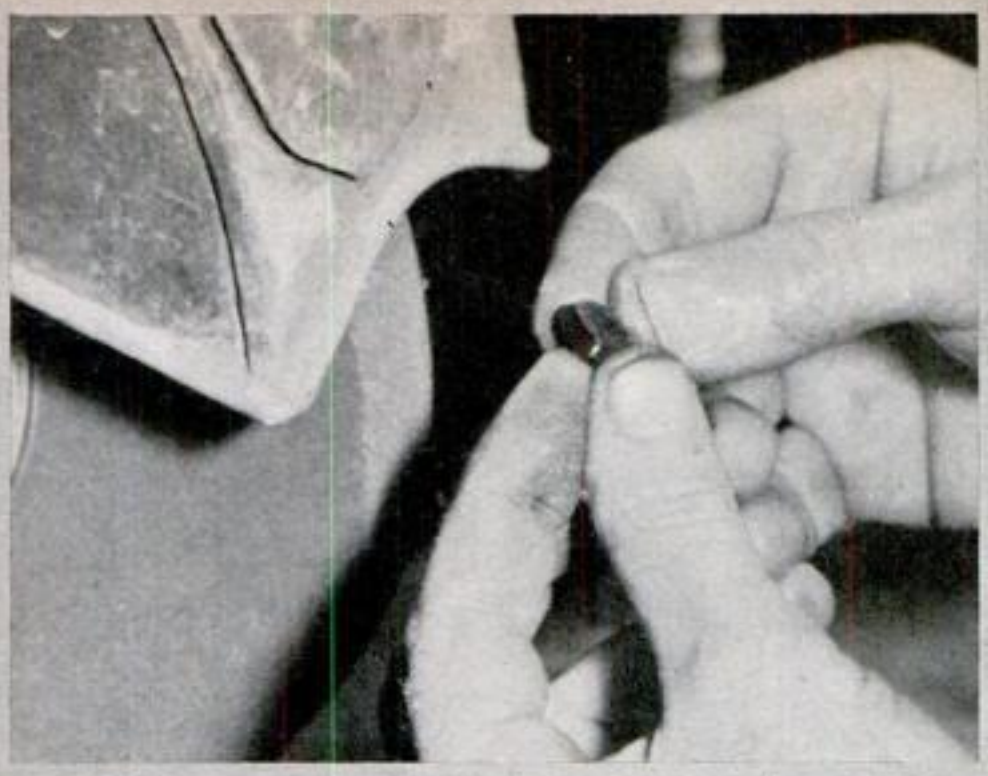


5 Now the stone is stuck on the cement. The purpose of the lapidary's stick is to provide a fixed and rigid holder for the stone during the polishing work

6 To assure accuracy, it is important that the stone be lined up correctly with the stick. This is done by reheating the cement and moving the stone into line

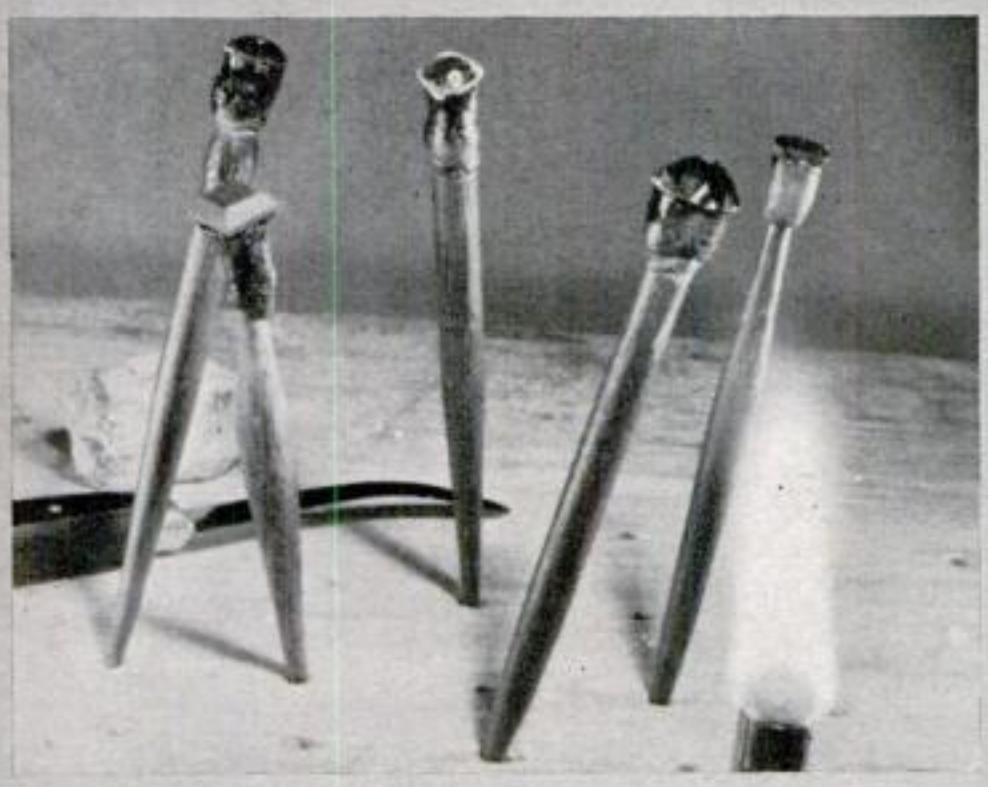
9 To get a uniform angle for each group of facets, the lapidary uses a "jamb peg" with numbered holes to brace the stick at different angles to the wheel

10 During grinding, Carborundum is applied to the wheel by means of a brush. In successive stages of grinding and polishing, softer abrasives are used

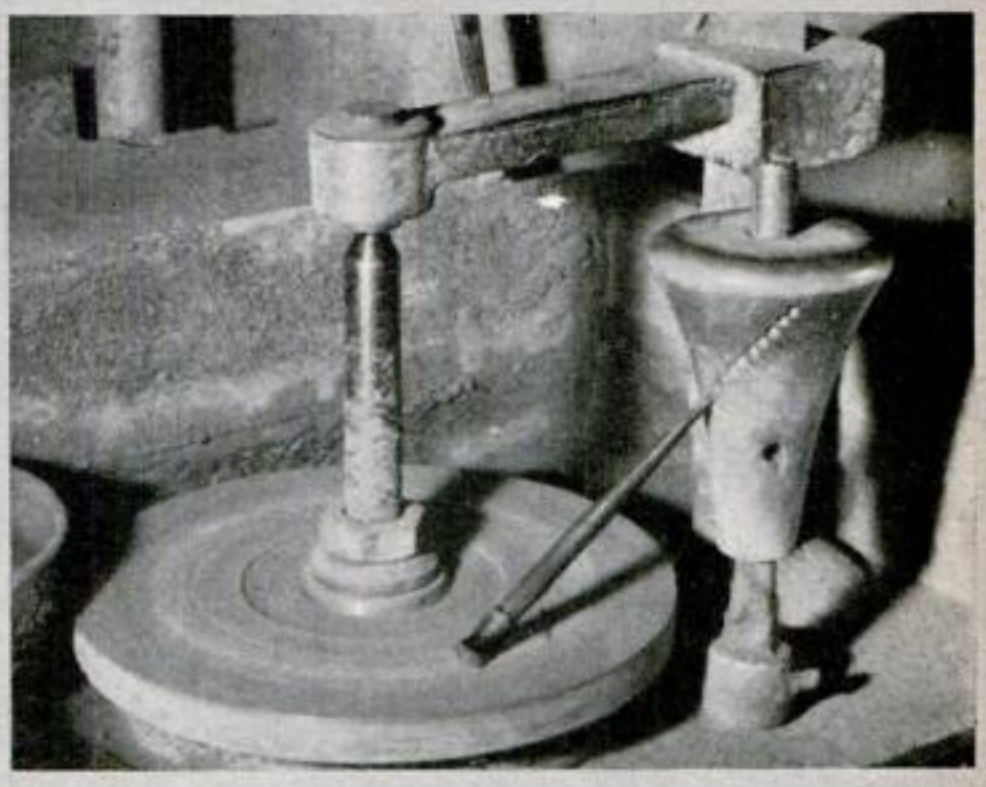


3 By examining the ruby after the rough grinding, the lapidary can determine its fine points and decide what type of cut will show them to best effect

4 Having planned his cutting strategy, he prepares to mount a simulated ruby on a lapidary's stick, a piece of wood resembling a penholder. Hot cement is applied

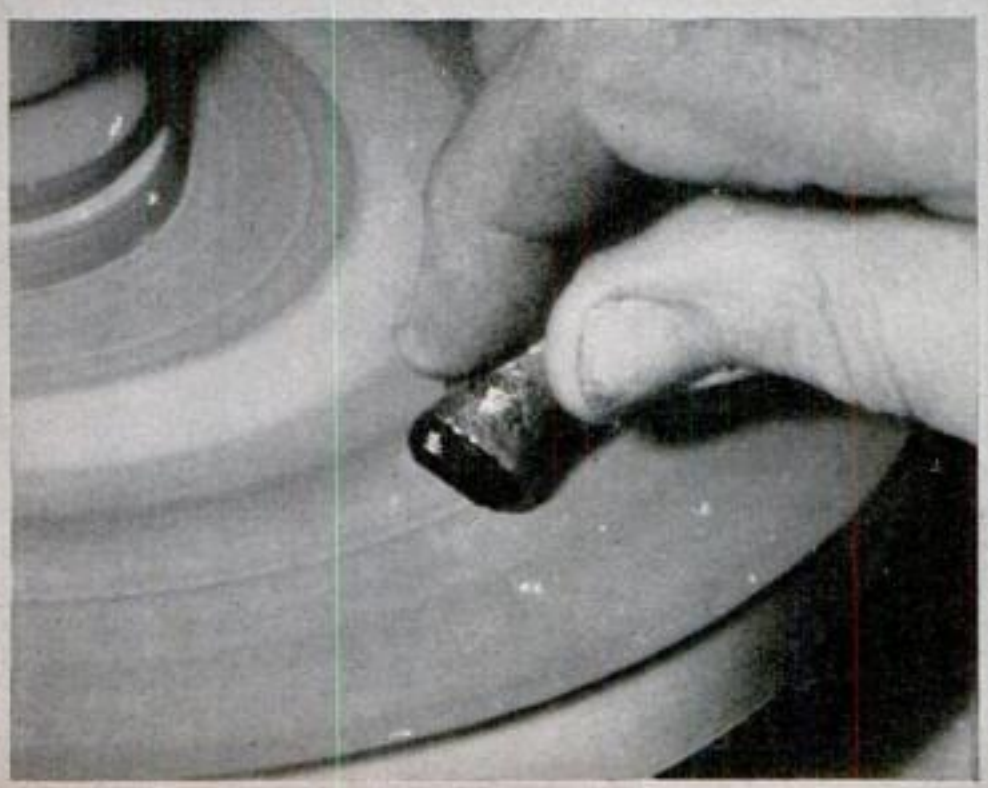


7 Here are four stones in different stages of cutting, each on its lapidary's stick. Holes in the bench make convenient places to stick the wood holders



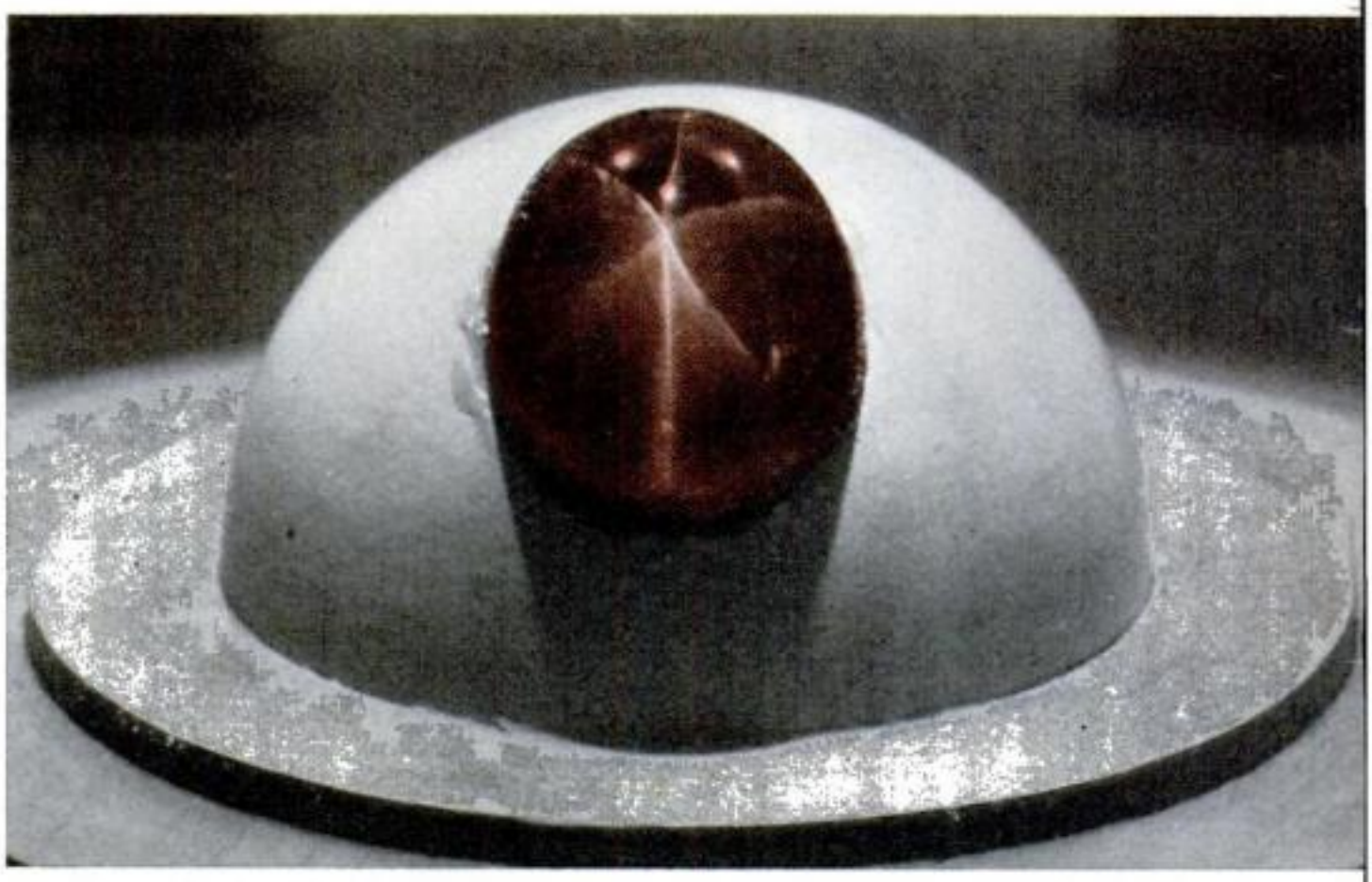
8 Facets are ground by holding the stick against a revolving horizontal metal wheel charged with Carborundum. Here the stick is in position before grinding

11 While the jamb peg serves as a rough guide, it is the skill of the lapidary's fingers and the unerring judgment of his eye that give true finish

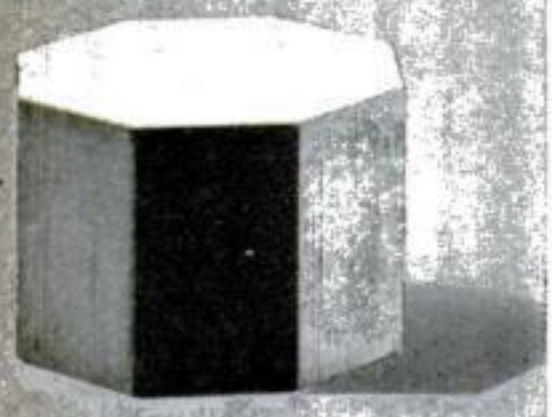


12 Examining the stone during facet grinding. When all facets have been cut, the stone goes to the polisher, who brings out all its finished brilliance

THE EDITH HAGGIN DE LONG STAR RUBY, SAID TO BE THE FINEST STONE OF ITS KIND IN THE WORLD. IT WEIGHS 100 CARATS. BELOW, HOW STAR RUBY IS CUT "EN CABOCHON"



Photographed at the American Museum of Natural History by Charles Coles



As demonstrated here with a wooden model, the stone is roughed out in octagon shape

Then the dome is gradually rounded down as the lapidary holds the stone against the wheel

Now it is finished—a perfectly rounded dome that brings out the starlike radiance

since poor coloring or bad flaws mar many rubies, the first-rate gems taken from any mine in the course of a year are few indeed. The British Government once gave a corporation, Burma Ruby Mines, Limited, a special permit to work the mines. At a cost of millions, the company installed expensive machinery of the most modern type, only to learn that primitive hand operation paid better. Voluntary bankruptcy for the company followed, and the hereditary native miners took over again.

These native operators usually employ four to six men, who average 40 cents a day for uncovering the most costly gems known to man. Theft is rare, perhaps because the grisly tale persists that in the old days miners who stole had their eyes put out and pebbles of the same size as the stolen gems inserted in the sockets.

The rubies are found in beds of a heavy gravel, known as beume, which lie from ten to 200 feet below the surface, usually in valleys or crevices between high hills. A shaft large enough for one man is cut and a miner goes down to put the gravel into a basket which is hauled up by a helper. The contents are poured into a large, roughly fashioned receptacle to be washed, and then dumped onto a flat surface to be sorted.

To bring out their true beauty as gems or their full industrial utility, rubies must, of course, be cut. The method used, whether in New York or India, has changed little in centuries. A rough fragment of gem material is sawed, or "slit," into convenient proportions by a thin circular disk of metal edged with tiny saw teeth to which a paste of diamond dust and water is fed. The actual sawing is done by the diamond dust. The stone is then cemented to the end of a piece of wood, about the size and shape of a penholder, which is called the "stick."

Having charged a horizontal wheel, or "lap," with Carborundum, the cutter holds the stick in an upright position against the lap to grind the top, or table, facet. This done, he cuts the main facets of the crown around the table and whatever others are required for the type of cut he has chosen. To help keep the angle of each group of facets uniform he employs a "jamb peg." This is simply an inverted, concave wooden cone, like a peg-top with a series of shallow holes at regular intervals. The end of the stick is rested in one of these holes to be sure that the stone will always face the lap at

the same angle. However, it is the skill of the lapidary's fingers and the unerring judgment of his eye which assures the fine points of proportion.

When all the facets of the stone have been cut, it goes to the polisher, who is the acknowledged master of the art. It is he who must bring the jewel to its finished brilliance and correct any irregularities.

Throughout the process a variety of ever softer abrasives are used to charge the wheels: diamond dust, carborundum, emery, fuller's earth, rottenstone, putty powder, rouge, and chrome oxide.

The stones are cut in various ways, depending upon fashion, the skill of the cutter, or the style that will bring out the best points of the particular gem in hand. The commonest cuttings are emerald or square, cushion brilliant, round brilliant, and seal cut. The star rubies, however, must always be cut *en cabochon,* or dome-shaped, and this type, having no facets, cannot be guided by the jamb peg. It depends entirely upon the lapidary's skill.

Industrials present an altogether different problem. They are "shaped" into a disklike form rather than cut. Once all industrial shaping was done in Switzerland, but since the war started, much of it is done here.

Thus, the ruby is both humble worker and the world's greatest luxury. It would be strange indeed if man had not tried to duplicate something so valuable, either for profit or science. About 1900, a Frenchman named Verneuil dropped a mixture of finely powdered ammonia alum and chrome alum into an oxyhydrogen flame. The mixture liquefied in the intense heat and, when cooled, solidified as a pear-shaped mass of exactly the same chemical composition as natural red corundum. It formed what seemed to be a perfect synthetic ruby which, when cut, appeared indistinguishable from the genuine.

Even today, most experts cannot detect one of these synthetics with the naked eye, though scientific detection is usually simple. Both genuine and synthetics almost invariably contain bubbles. When examined under the microscope, the bubbles in the natural variety are angular in shape, while in the synthetics they are always round. Then, the grain of the synthetics is curved, while that of the real stone is straight. And synthetics will glow in front of an X-ray tube, while the genuine will not.

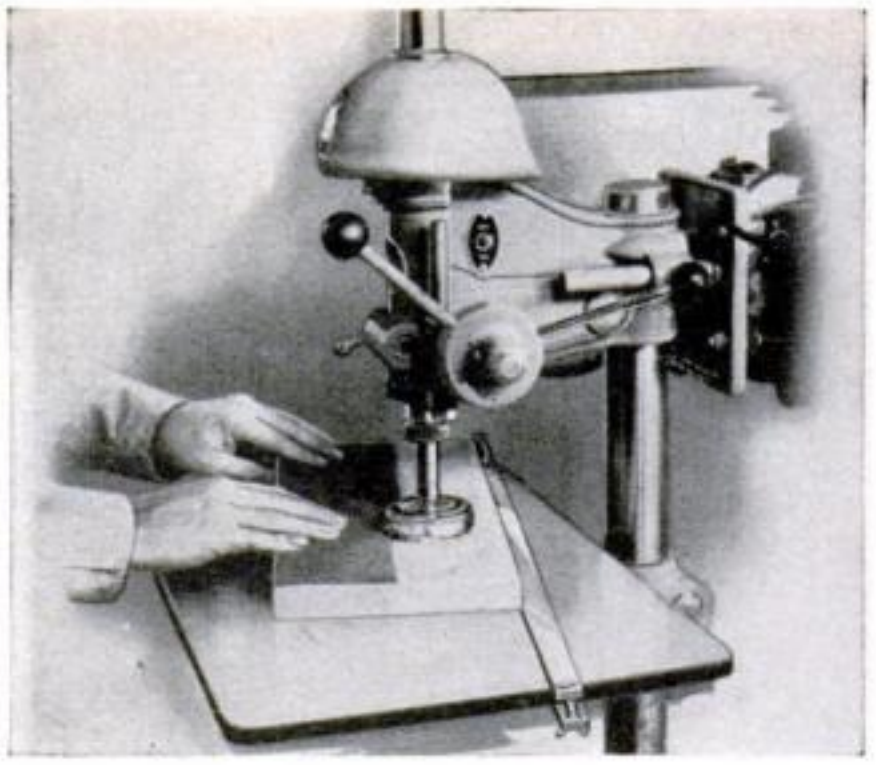
Although the chemical composition, hardness, specific gravity, and refractive index of the synthetics are identical with the genuine, they have never been able to replace it.

Ruby-cutting photos by Samuel Schneider

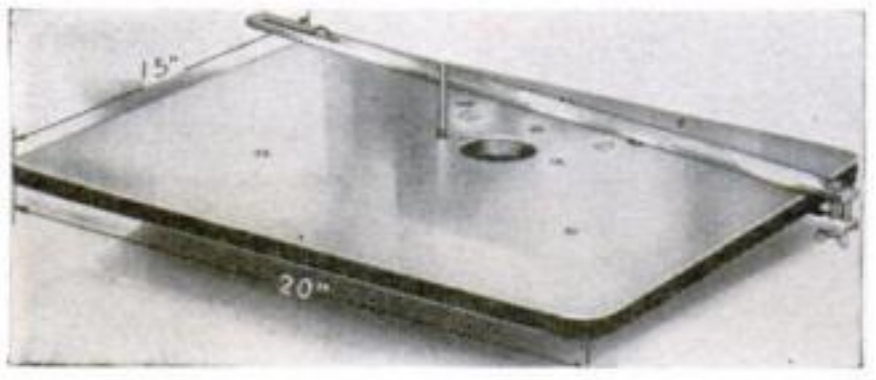
A lapidary examining a star ruby. When it is cut in the shape of a dome, a starlike radiance glows from the heart of the stone. Star rubies are highly prized for beauty

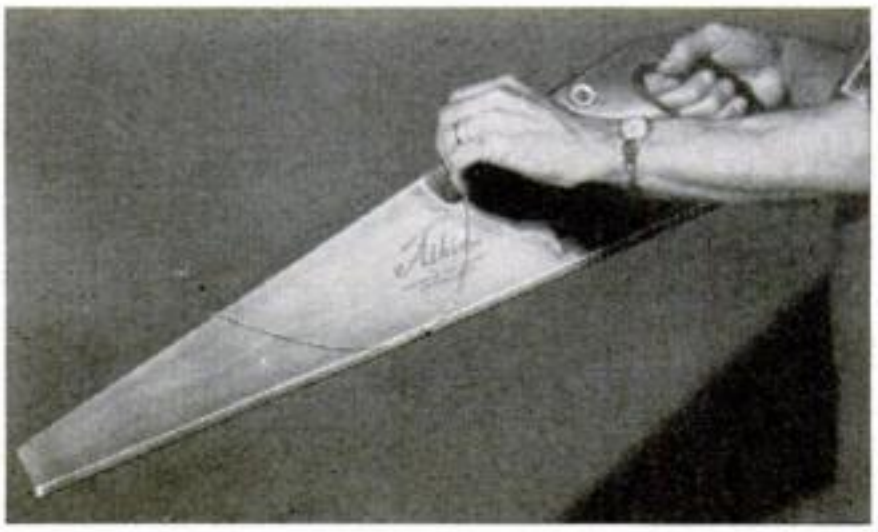
Because they must always be cut "en cabochon," or dome-shaped, and therefore have no facets, star rubies make special demands on the lapidary's skill. Unable to use the jamb peg, he must depend altogether on the skill of his fingers and judgment of eye

New Tools

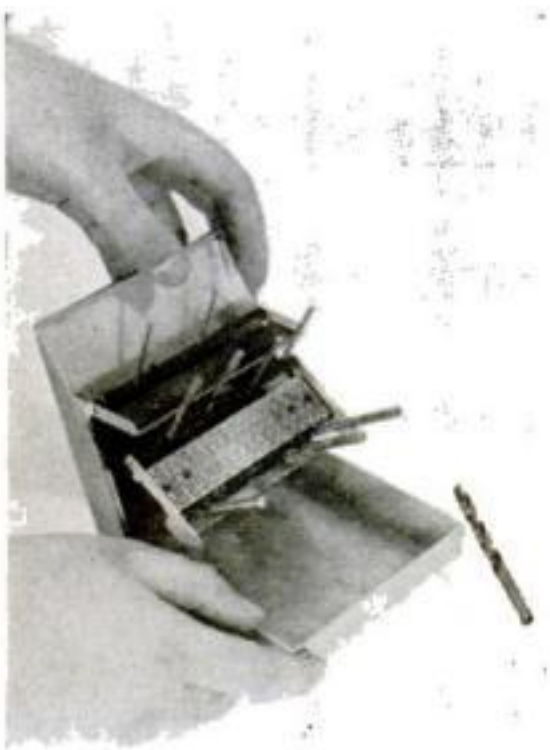


AUXILIARY WORK TABLE. Providing an extra large, true working surface to insure greater ease of operation and added accuracy, this steel-top table is made of heavy-gauge steel bonded to a plywood base. It may be used as a guide in surface grinding, sanding, drilling, routing, paneling, rabbeting, and tenoning work. Measuring 15 by 20 inches, it fits any type drill press and is complete with anchor studs, threaded bushings, irregular shaping pin, and special pivoting fence with wing-nut clamp.





THIS NEW GUARD for hand saws touches only the extreme front and rear points, thus protecting all of the teeth when the saw is not in use. A spring-steel wire clip applied to the center of the saw holds the guard in place; clip is out of the way when guard is taken off. Made of copper-plated dead soft steel with a longitudinal arched body to prevent contact with the teeth of the saw, the guard may be filled with vaseline to prevent rusting. The size shown at left is for a 26" saw; for shorter blades the guard may be cut to desired length with tin shears.



A POCKET DRILL CASE, 4½ inches square by 4¼ inches deep, holds one to 60 drills. When it is opened, they stand erect in a three-tier arrangement, making selection easy. Slots are formed to make it impossible to put a drill back in the wrong place.

TRANSPARENT PLASTIC makes the hollow-topped screw driver at right a visible tool box. A twist of the wrist gives the choice of four bits, two for star-slotted screws and two conventional blade types for large and small screws. The steel shank is molded to the handle.

Un-Natural History

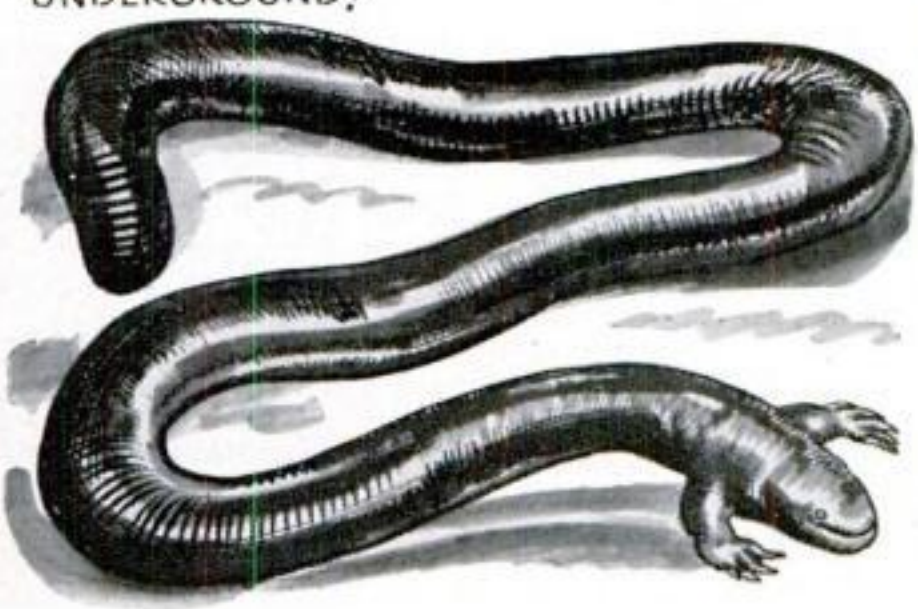
BY Gus Mager

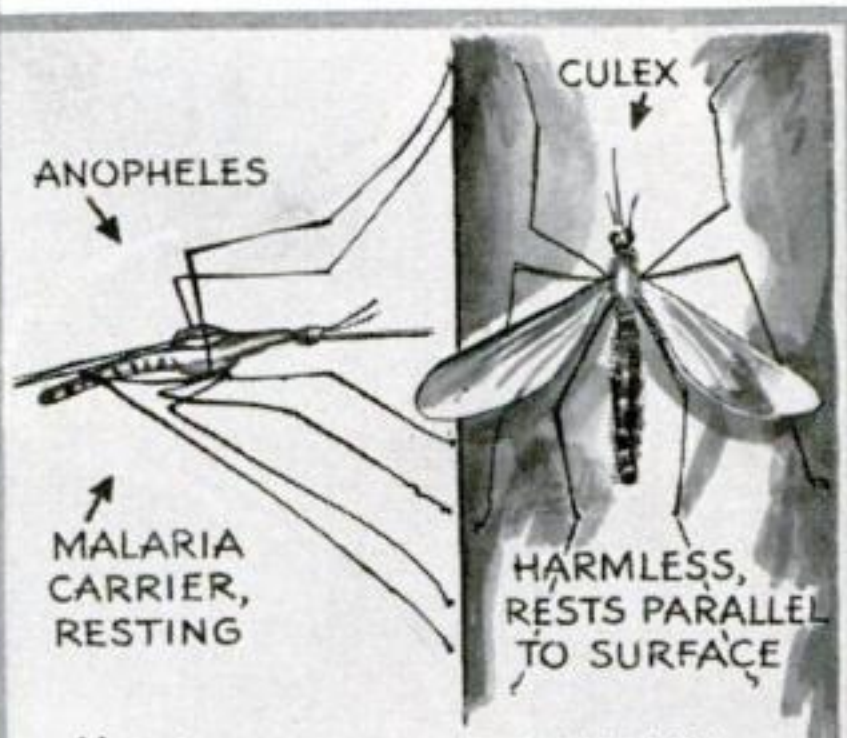
DOGS ARE COLOR-BLIND! SINCE THEY CANNOT DISTINGUISH RED AND GREEN TRAFFIC LIGHTS, SEEING-EYE DOGS ARE TRAINED TO RELY ON SCENT, HEARING, AND OBSERVATION IN GUIDING THEIR BLIND MASTERS ACROSS STREETS!

THE **WOOD IBIS** IS THE ONLY NEAR RELATIVE OF THE STORK THAT IS NATIVE TO AMERICA!

THE AMAZING **PORPOISE** LOOKS LIKE A FAT, CLUMSY PIG, BUT IT CAN DO FIFTY MILES AN HOUR AND TURN RIGHT-ANGLE CORNERS AT TOP SPEED!

HERE IS A **TWO-FOOTED WORM LIZARD!** IT IS NINE INCHES LONG AND EACH OF ITS TWO FEET HAS FOUR WELL-DEVELOPED CLAWS AND A FIFTH TOE WHICH IS CLAWLESS! FOUND IN SOUTHERN AND LOWER CALIFORNIA, IT SPENDS ALL ITS TIME UNDERGROUND!





HERE'S HOW TO TELL THE MALARIA-CARRYING **ANOPHELES** MOSQUITO FROM THE RELATIVELY HARMLESS **CULEX**: WHEN RESTING, THE ANOPHELES STICKS ITS BODY OUT AT RIGHT ANGLES TO THE SURFACE, WHILE THE CULEX HOLDS ITS BODY PARALLEL!

Policing a Nation at War

J. Edgar Hoover, in an Exclusive Interview, Tells of Plans to Meet the Threat of Raid or Invasion

By ARTHUR GRAHAME

"SHOULD invaders ever set foot on our shores, whether they come by water or by air, there won't be any blackout of protection for civilians in America!"

When that determined statement is made by J. Edgar Hoover, the forceful director of the Federal Bureau of Investigation, you know that there is a lot more than wishful thinking behind his words. Some few years ago he said that his FBI was going to smash the kidnaping racket. Now the kidnapers have ceased from troubling us. A little later he said that his FBI was going to rid the country of the murderous gunmen who were terrorizing it, and now the grass grows green on the graves of the Baby-Face Nelsons.

Back in those days J. Edgar Hoover was calmly confident that the crime-fighting organization he had built up was capable of doing any job he asked it to do. Today, facing what may very well turn out to be the biggest law-enforcement job that anyone ever has tackled anywhere, he is as calmly confident as he was in those almost-forgotten days when to most people John Dillinger seemed a much more dangerous menace to the American way of life than did Adolf Hitler.

But Hitler and what he stands for is the menace now. Although the danger of attempted invasion and even of large-scale air attack seems remote, it must be considered —and so must the protection of civilian life and property in the event of such attacks. Who would provide that protection, I wanted to know.

"The same men who protect the citizen's life and property in peacetime," Mr. Hoover said. "Our professional police officers. In war as in peace, law enforcement is a job for the trained professional. Panic and mass hysteria are favorite weapons of the foreign powers which plot to destroy the United States—from without or from within. In the event of attack or invasion, much—perhaps everything—would depend on the courage, devotion, and war-

Helping the civilian population in gas attacks is a wartime job for which police must be prepared. Here a London bobby is showing a game youngster how to adjust his mask

duties training of our professional police officers.

"In Britain the policeman has been and is a most important wartime figure. Even while the bombs are falling the 'bobby' represents the permanence of law and order. He stands at his post in the midst of death, destruction, and confusion, and calmly gives directions and advice. London and other British cities have had many devastating air raids, but no general panics. To the police must go much of the credit for that.

"Members of the American law-enforcement profession ranging from village constables to metropolitan police chiefs are being thoroughly prepared to meet and master any emergency which international developments may bring. Last fall, two-day administrative training schools for police executives were held at 54 field division headquarters of the FBI, and were attended by over 5,000 police chiefs and other executive heads of police agencies. These schools were followed by more detailed six-day courses for selected subordinate officers of local and state police forces which were conducted by the FBI in 260 key cities throughout the nation and were attended by about 30,000 law-enforcement officers.

"I want to emphasize that this war-duties training is purely precautionary. As we instruct police officers in methods of enforcing blackouts and decontaminating gas-drenched areas we fervently hope that they never will have to make practical use of this knowledge."

What, I wanted to know, did these policemen-students learn at the war-duties schools?

"They learned," Mr. Hoover said, "what our observers learned while studying the methods used by the British police under actual war conditions.

"To prepare for our training program, in the fall of 1940 I detailed two high-ranking officials of the Bureau to go to London and study—under bombing—the protective and preventive measures used by Scotland Yard and other civilian defense agencies. These observers brought home with them a valuable collection of samples of various pieces of equipment used under blackout conditions in urban areas—protective clothing, light-proof ventilators for homes and public buildings, various types of street lights, special headlights for ambulances and police cars which project small beams of light, and traffic-control signals visible for only a short distance. All the lights are designed so that no glare can be seen from above.

"The proper method of blackout enforcement is one of the most important subjects taught in our courses. Our instructors have found that there is a good deal of misunderstanding in respect to the nature of an effective blackout. The complete extinction of all lights is neither necessary nor desirable. Under actual war conditions, military and industrial operations must be continued, or the war effort suffers. Headlights on automobiles, street lights, railroad signal lights, and illuminated air-raid shelter signs must be kept burning, but with drastically reduced power. Street lights, for example, are dimmed until their illumination at street level isn't more than 2/1,000 of the amount of light given off by a single candle at a distance of one foot. But in the murk of a blackout even the faintest glimmer of light is highly useful.

"Quick and efficient methods of evacuating people from danger areas, especially from the immediate vicinity of unexploded bombs, are very important, and are taught in our courses. At one time there were over 900 unexploded bombs in the streets of London, and each of them required the evacuation of varying numbers of people to a distance of at least 100 yards. Think of the amount of doing that job demanded, with the bombs still coming down, big fires raging, and many streets blocked by bomb craters and debris!

"Then there's the often ticklish task of dealing with grounded enemy airmen. I wonder what the average American peace officer, if he hadn't attended one of our war-duties courses or been in close association with some brother officer who had, would do if an enemy plane came down in his territory with its crew uninjured, and military assistance wasn't immediately available. Arrest the flyers for unlawful entry into the country, or as unregistered foreign agents, or for flying without a license? Any one of those charges could be made to stick in court—provided that the airmen, who usually are armed, consented to follow the officer to court. If they put up a fight, an American law-enforcement officer would be in a much better position to handle the incident than is the British policeman. American officers are armed and most of them are at least fairly skilled in handling their guns. Tradition says that British policemen shall be unarmed—and they still are, even after over two years of war, during many months of which fear of immediate invasion was acute.

"Those are just a few of the subjects in which carefully selected officers of local police agencies receive instruction in the FBI's war-duties schools. Another is police communication by radio and wire. Still another is the handling of Army convoys in coöperation with the military authorities, and the handling of civilian traffic under emergency conditions. Air-raid duties are stressed. So is protection against possible gas attack,

War-duties training for American police officers includes reproduction of all the conditions met with under air attack and siege. Here a dummy building is afire in a demonstration of the proper methods of handling civilians when fire bombs fall

and so are methods of conducting espionage and sabotage investigations. Then there is the preventing of looting and similar crimes.

"In 1939 the President designated the Federal Bureau of Investigation to serve as a clearing house and coördinating agency to handle law-enforcement activities connected with national defense. The war-duties courses for local and state police agencies are a logical development of this tremendous responsibility placed on the FBI. They are a major contribution to nationwide coöperation between local and federal law enforcement.

"The FBI National Police Academy, which was started in 1935, has done wonders in helping us to achieve the present high degree of coöperation with local police agencies. Three 12-week sessions are held in Washington each year. To date 627 carefully selected representatives of municipal, county, state, and other Federal law-enforcement agencies have been graduated from the Academy. Each of them has re-

Evacuation of people from the vicinity of unexploded bombs is a ticklish task that falls to the police. In London, such areas were roped off and guarded, as pictured below, until danger had been removed

turned to his home community and established and conducted a training school for the other members of his department. Through the work of the National Police Academy advanced police training has been made available to more than 90,000 police officers.

"The exceptional crime-fighting facilities of the FBI are available to local law-enforcement agencies—the Technical Laboratory in which over a hundred scientists make metallurgical, spectrographic and other technical examinations of evidence in sabotage and espionage as well as ordinary criminal cases, and in which they do some highly confidential work on secret writings, codes, and ciphers in counterespionage work; the Fingerprint Identification Section, which has the world's largest reservoir of criminal records based on fingerprints; and the compilation of crime statistics submitted monthly by the police forces of the country. The FBI wants the help of local police agencies in its work, and it wants to give those agencies its help in their work."

Back in World War No. 1 a bewhiskered gentleman with a mysterious tin cylinder came to Washington and was trailed around town for a day by the agents of six Government and volunteer organizations. Next morning he got in to see the Secretary of War, and the six sleuths learned that the sinister tin cylinder contained plans of some contraption which a patriotic inventor wanted to give to the Army to help win the war! That incident was good for a laugh—but some of the results of overlapping authorities in counterespionage work were not laughing matters. So I asked Mr. Hoover if such things can happen now.

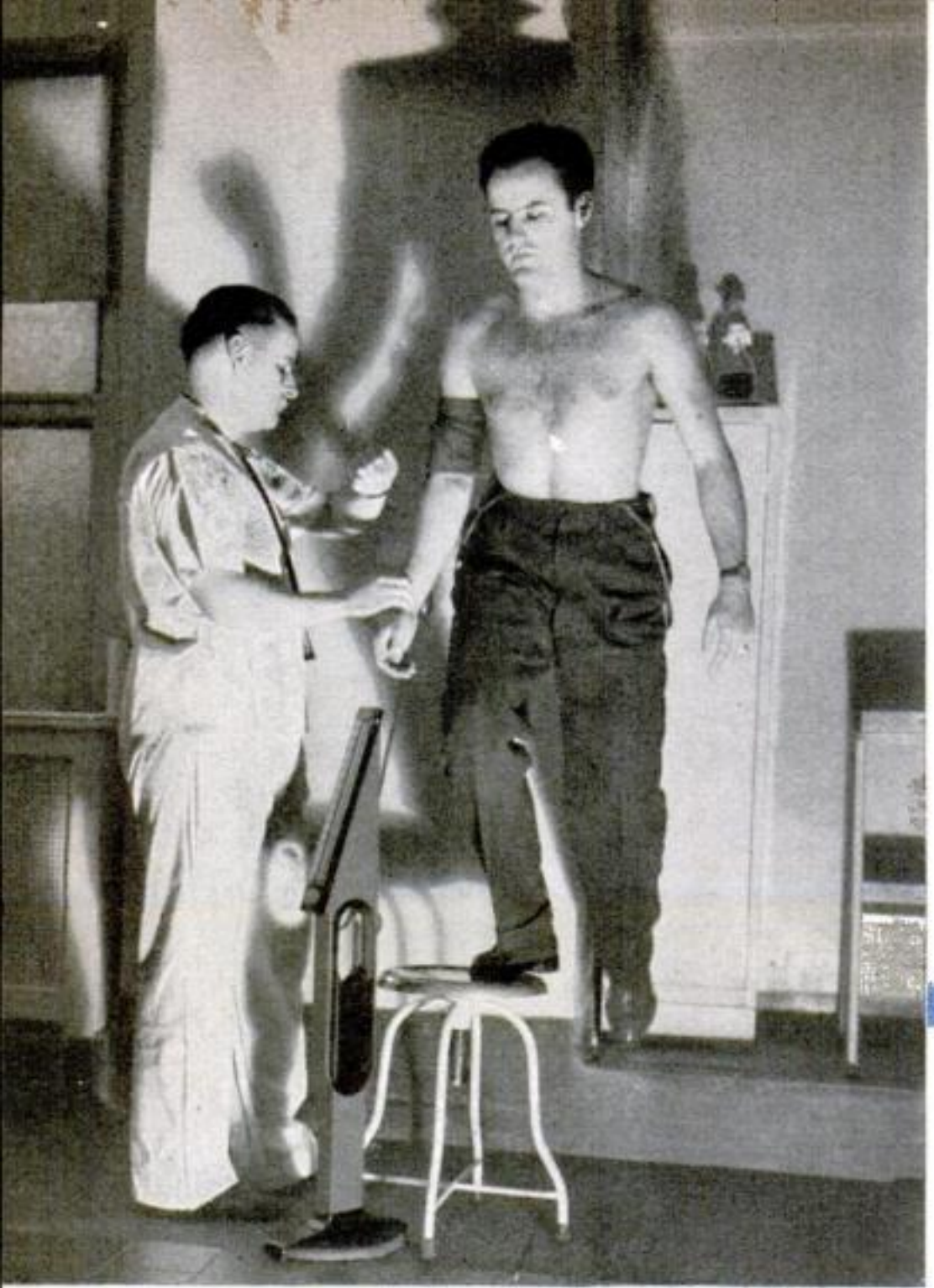
"Most definitely they can not!" he told me. "The confusion which existed during World War No. 1 as the result of the uncoördinated activities of numerous organizations was eliminated when, in June of 1939, the President placed full responsibility for all espionage, counterespionage, and sabotage matters on the FBI, the Military Intelligence Division of the War Department, and the Office of Naval Intelligence of the Navy Department. No investigations may be conducted by other agencies of the Government, and all information pertaining to espionage and sabotage is turned over to the FBI, which acts as a clearing house."

I had one more question to ask. "What can the ordinary citizen do to help?"

"Sometimes he can do a lot—if he goes about it in the right way," Mr. Hoover said. "Over in London, early in the war, a man walked into a tavern one afternoon and asked for a whisky and soda. He looked like a Britisher and his English was perfect, but the barman became suspicious. For years, British taverns have had to close their bars during certain hours in the afternoon, and the barman thought that any Britisher would know about it. He 'phoned the local police station, which in turn contacted the service which in England does work similar to that of the FBI. The suspect was questioned, and soon admitted that he and a companion had that day landed from a small fishing boat which had brought them from occupied France. The companion was found in a near-by field, with two portable short-wave radio sets. Both men were tried, convicted and executed—the first spies to be executed in England during the present war.

"That sharp-witted barman did just the right thing when he reported his suspicions to the police, and left the rest to trained officers. That is just what we want every American citizen who sees anything which seems to him to be suspicious to do—report to the FBI or the local police. Vigilante organizations and self-appointed investigators are wholly undemocratic, and they interfere seriously with planned investigation. The law-enforcement officers of America have been trained to handle any emergency. It is the duty of every citizen to help his local officers and the FBI at every opportunity—but they should not attempt to do the professional police officer's work!"

An FBI display of gasproof clothing and other protective equipment prepared as the result of a study of British measures by high-ranking G-men who went to London



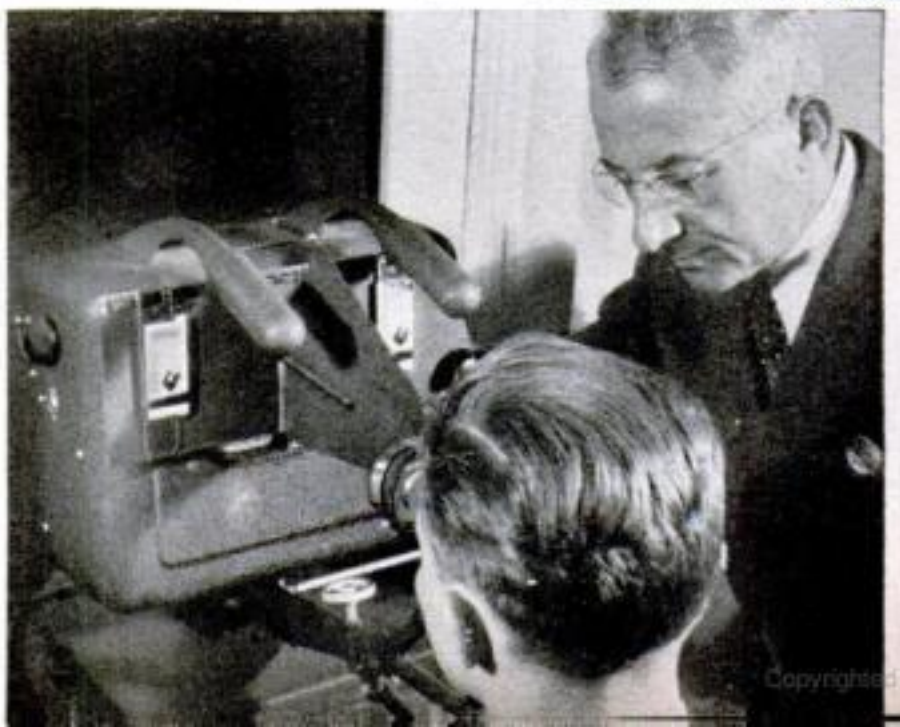
WHEN the Navy calls, as it did not long ago, for 25,000 young men to fly its fighters and bombers, it takes 250,000 applicants to make up the quota. Only 20 men in a hundred are accepted for the United States air services, and of that 20, ten are dropped for minor physical or educational handicaps in the grind of training.

What of the men dropped for that minor nose obstruction or this slight visional defect? It was to salvage these boys who are, but for slight physical flaws, potential pilots in every sense, that Aviators' Post 743 of the American

Thomas J. Brennan, Jr., rejected by the naval air corps, gets a Schneider index test in Gotham Hospital, which is aiding in the work of salvaging rejected flyers

Picking up a ball with the toes is recommended for the cure of flat feet, which flyers shouldn't have

Below, a young man's eyes are being trained in the myoculator, which swings a target in front of them



Just a little something is wrong with 10% of the young men who want to fly for the U. S. But they can be fixed up—and here's how it's being done

Legion set up the American Flying Services Foundation.

A nonprofit organization with members in 160 key cities in 35 states, the American Flying Services Foundation is daily giving the aid these young men need.

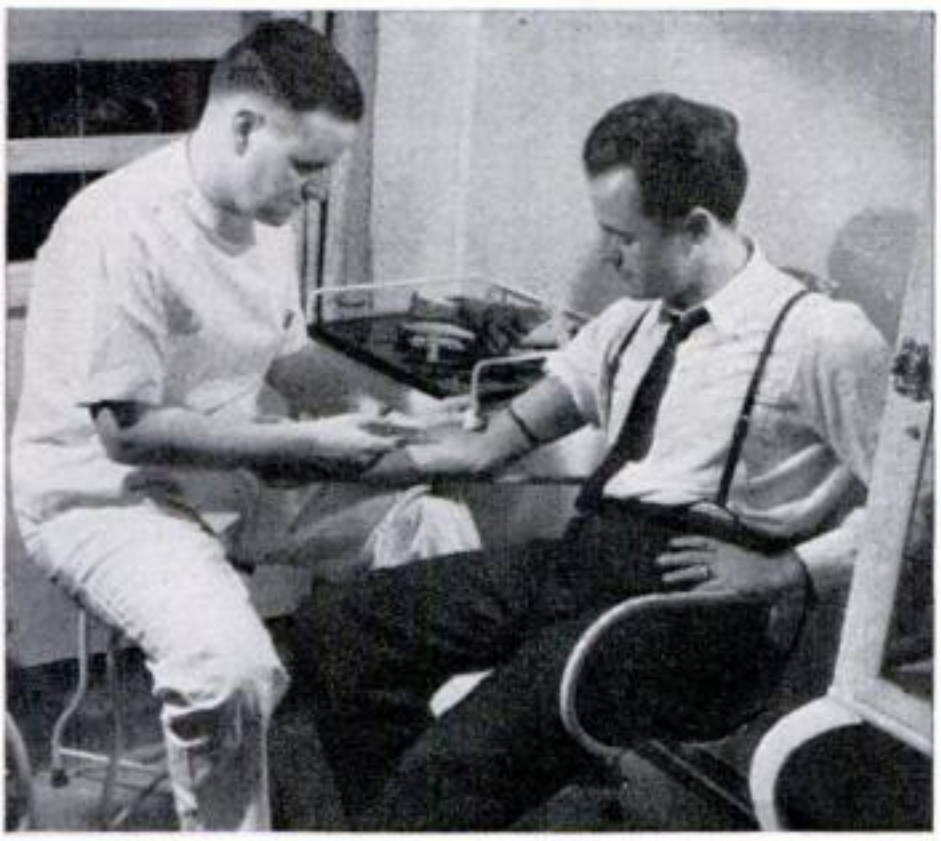
More than 5,000 young men have gone to the foundation's New York offices. Many have sought only advice, but 450 have received valuable scholastic assistance, and 200 others have received medical aid, either free or for whatever the applicant can pay.

A young man rejected from the Air Corps for flat feet is sent to a specialist who usually recommends a simple exercise routine to build up weak muscles, such as picking up a ball with the toes. Varicose veins are cured by injections, as are such nervous conditions as polyneuritis, in which case the injections are of nicotinic acid followed by a diet rich in vitamin B. Operations remove obstructions to breathing, impediments to hearing, and slight hernias.

Dr. Herman J. Gould, Brooklyn orthoptist, has given his time and equipment freely to boys sent to him for eye treatment. Most of these boys have eyes which, they say, never trouble them. They have perfect vision, yet Army and Navy doctors have found that their eye muscles are out of control; that they have poor converging or diverging ability.

With a myological machine used for neuro-psycho-refractive work, Dr. Gould is able to determine in what manner the muscles fail to function, and to set up a cure.

Whatever the salvaging operation, the American Flying Services Foundation is today responsible for the reclassification of many a promising young man, for whom the Army or Navy air force had given up hope. Their motto is: "Start 'em Flying!"



Left, Brennan is getting an injection of nicotinic acid, a treatment for vitamin deficiency causing many nerve ailments. His diet also will be changed

Brennan made the grade. Below, with another cadet, he is talking to the naval air corps officer who swore him in, after two months of "salvage" work

The prospective flyer below is strengthening the muscles of his abdomen by inhaling and rising to a sitting position, and exhaling as he lets himself down to the floor

HOW IT IS DONE

Beating

INGENIOUS MACHINES TURN PULPWOOD LOGS INTO MAGAZINE PAGES

PAPER makes headlines today. Consumption leaps as the Army uses it to wrap shells, and to package tinned food. Waste paper is solicited, to be turned into new. Chlorine gas, used both in munitions and in bleaching paper, must be conserved. But how many people can tell how paper is made?

Grades range from the coarsest of newsprint to high-quality rag paper, manufactured from the cuttings of shirt factories. Processes vary with each type of paper. The kind on which this magazine is printed probably offers the best example, since it combines two of the most widely used methods. They are illustrated here in photographs and drawings made especially for POPULAR SCIENCE MONTHLY through the courtesy of the St. Regis Paper Company, at its Deferiet, N. Y., plant.

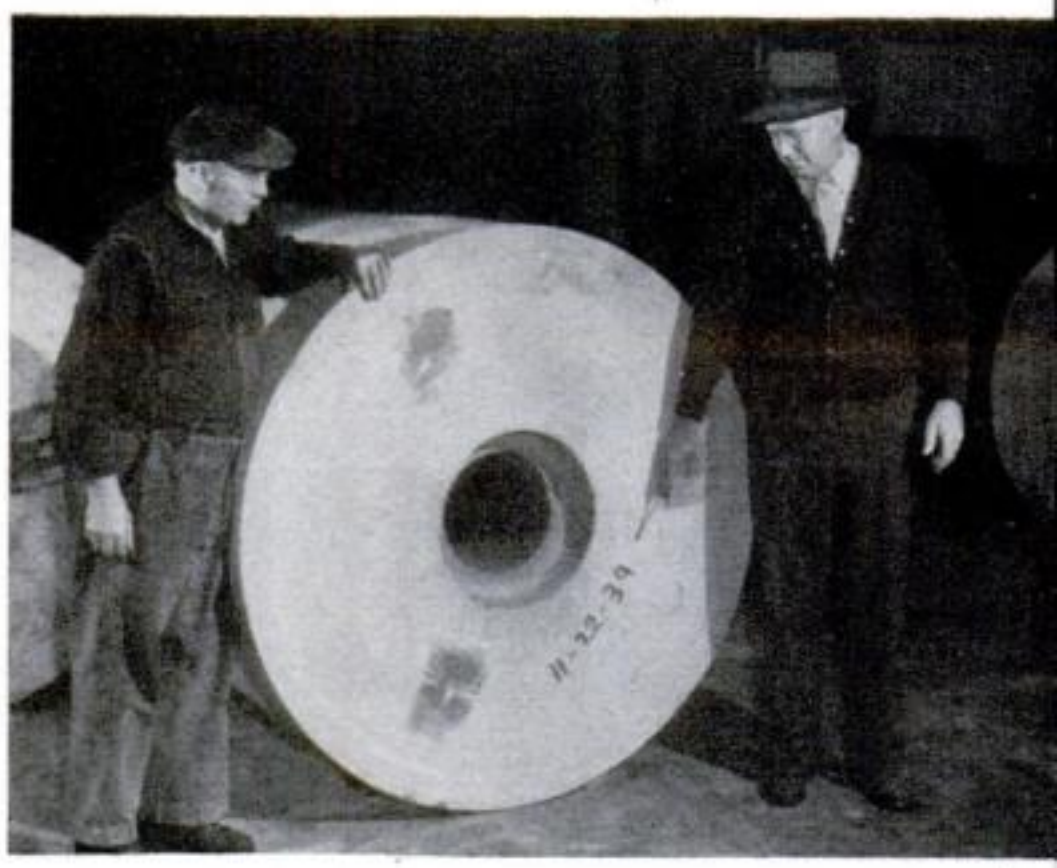
Pulpwood, the raw material, arrives at the paper mill in the form of four-foot logs of spruce and other wood, stripped of their bark. When the sap is running, the bark may be peeled off by hand. Otherwise, portable or stationary machines make short work of the task.

Suppose these barked logs are to be made into paper by the bleached sulphite process, a chemical one. Conveyors deliver them from the yard of the mill to the revolving knives of a powerful motor-driven cutter. When they emerge from the noisy machine, they have been completely chopped up into thin flakes, up to an inch or so long.

Now the wood chips go into the top of one of a bank of "digesters," several stories high. In this huge vessel they are cooked with a sulphite liquor that breaks down the fibers, to form a yellowish mush called pulp. Chlorine bleaches the product. Stored in a metal tank, in compressed and liquefied form, the chlorine is vaporized as needed by being drawn off through a steam-jacketed heater. This treatment gives the pulp a snowy-white color. In tint and texture, it might easily pass for a white cooked breakfast cereal.

In contrast with this chemical method, the groundwood process operates

1 In the bleached sulphite process of making paper, wood chips slide into the top of a huge digester to be cooked with chemicals until they become pulp —a yellowish mush that is bleached with chlorine



3 In the groundwood process, logs are ground to bits by big grindstones like this. Date shows the stone has weathered for more than two years, as required for toughness. It will go into a "pocket grinder"

4 Inserting a log into a three-pocket, 500-hp. pocket grinder. Jaws of hydraulic piston, whose cylinder is in the right foreground, force the log into contact with the whirling stone. Despite a system of water-cooling, the product, which comes out looking like wet sawdust, is too hot to handle with comfort

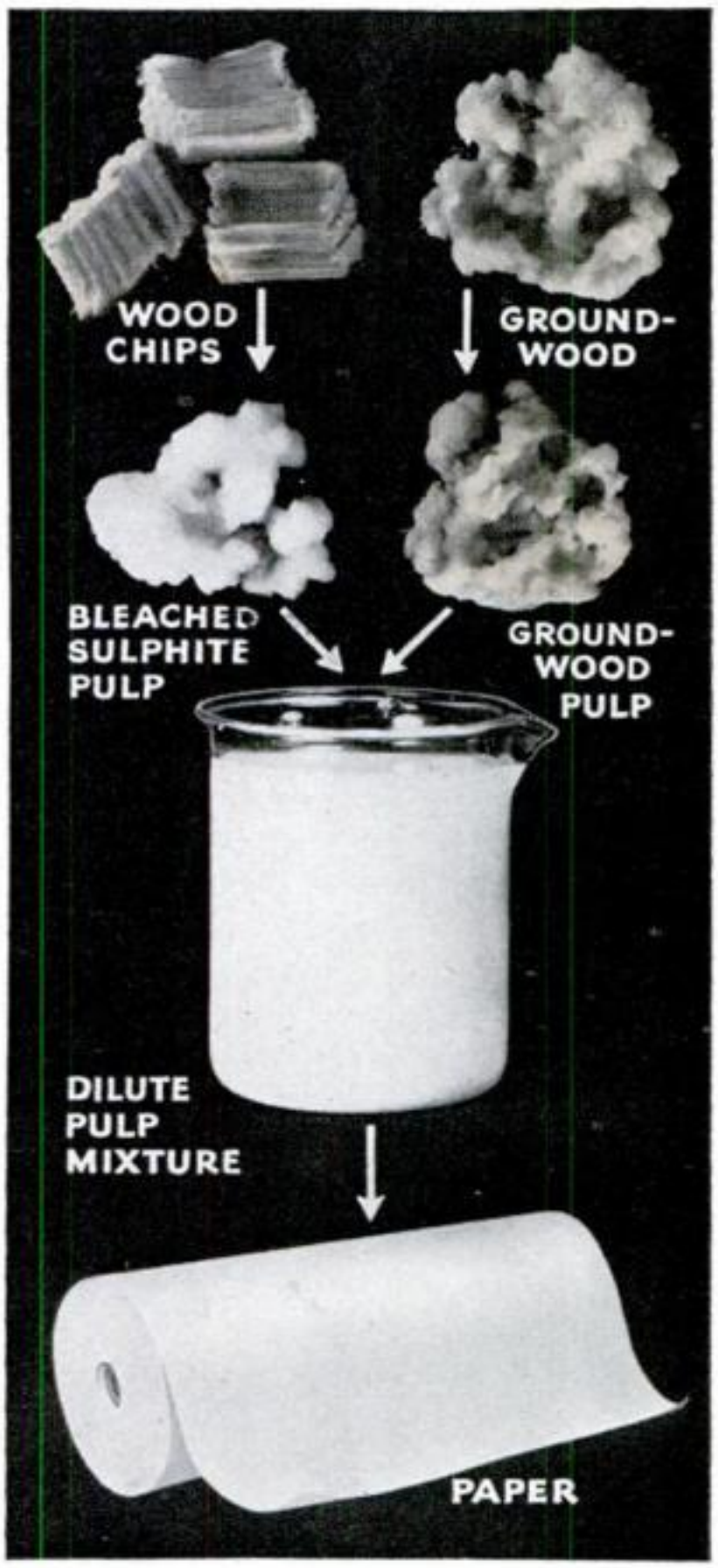
Forests Into Paper

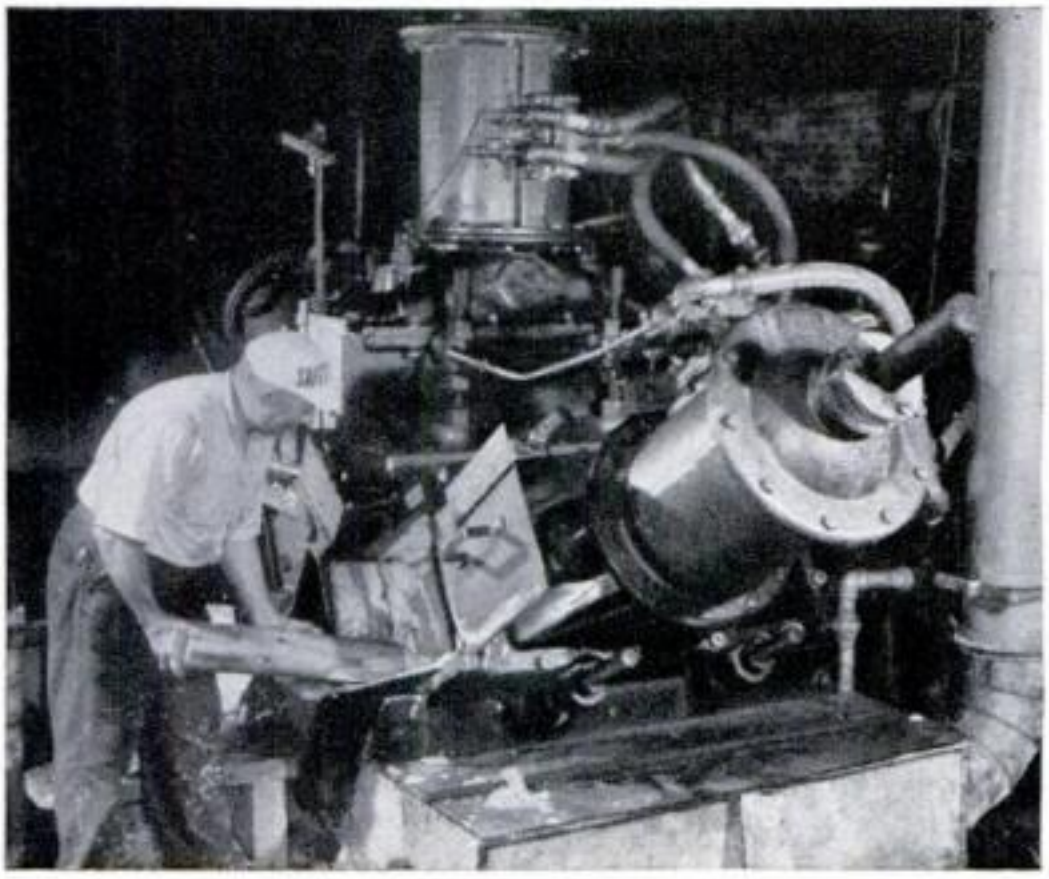
entirely mechanically. In a machine called a "pocket grinder," hydraulic pistons apply a pressure of 50 pounds to the square inch to force logs against a big revolving grindstone. What comes out is moist wood flour called groundwood—kept down to 160 degrees by water cooling, but still too warm to be held comfortably in the hand. A battery of 24 such grinders, three to a shaft, may occupy a room of a groundwood plant.

Occasionally, large splinters slip through the grinding machine. To catch and remove them, the groundwood passes through a succession of screens. Then, borne by water, it circulates through a series of sluiceways where particles of grit settle out. Finally reconcentrated, the brownish groundwood pulp looks exactly like cooked oatmeal.

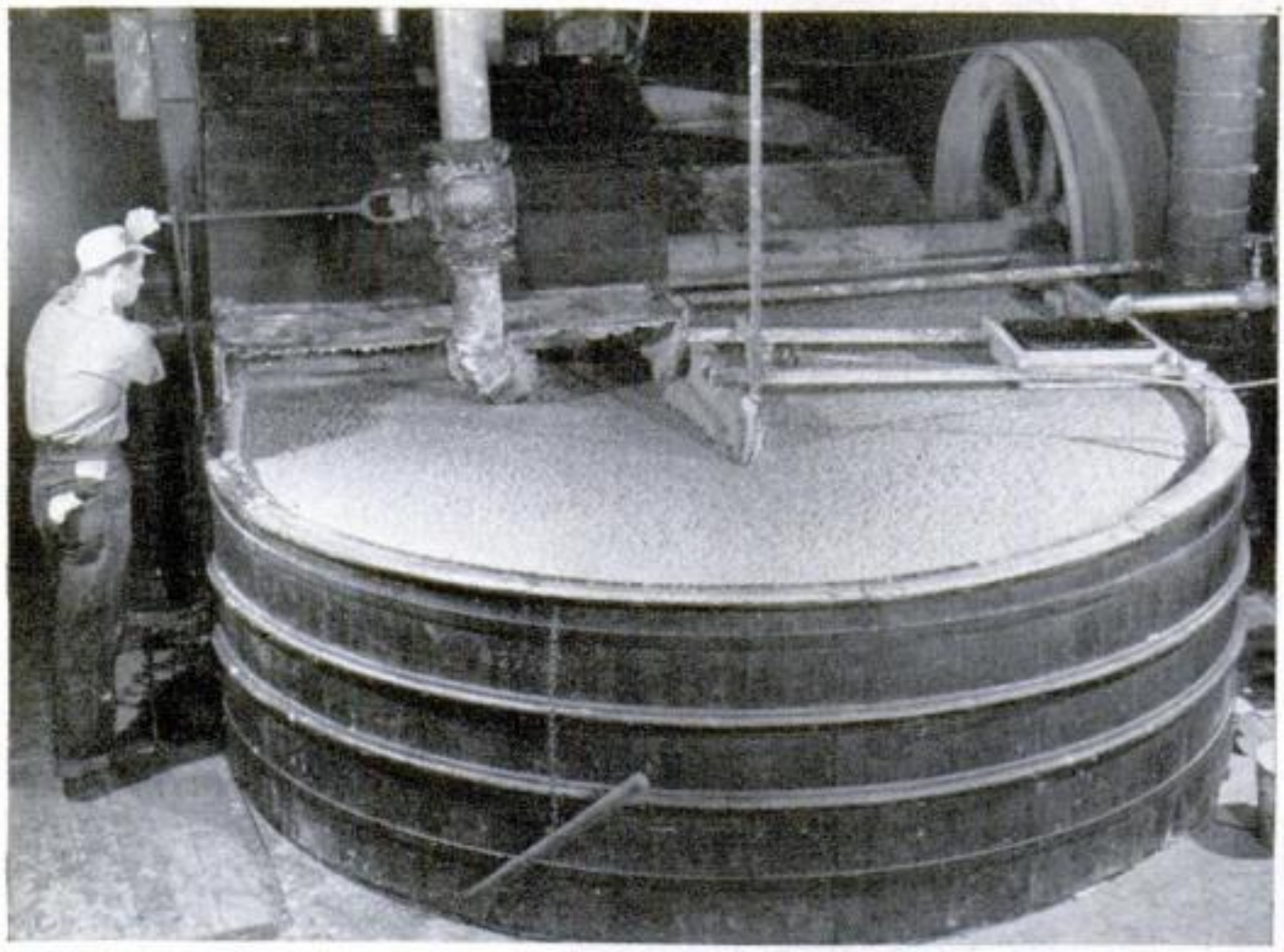
Either chemically or mechanically produced pulp may be used alone to make paper. But a mixture of the two, used for paper of the sort these words are printed upon, combines their advantages. The bleached sulphite pulp adds strength and lightens the

2 Above, the digester cover is lowered for the cooking to begin. A final chlorine treatment bleaches the pulp from a yellowish color to a snowy white





Above are the successive steps and intermediate products of the two different processes used in making paper. The two kinds of pulp are mixed for the paper in this magazine. (CONTINUED)



5 Beater, above, pounds the combined pulp from the bleached sulphite and groundwood processes into finer particles, preparing it for the great Fourdrinier machine, where the diluted pulp is made into finished paper

Drawing by B. G. SEIELSTAD

❸ FIRST PAPER FORMED IS LIMP, DAMP, AND EASY TO TEAR

STEAM-HEATED ROLL

RUBBER BELTS KEEP PULP FROM FLOWING OFF SCREEN

SUCTION BOXES COMPLETE DRAINAGE OF FREE WATER

❷ WOOD FIBERS MAT INTO PAPER AS WATER DRAINS OFF THROUGH ENDLESS BRONZE SCREEN

WOOD PULP TRAVELS WITH SCREEN AT 300 FT. PER MINUTE

ROLLERS SUPPORT SCREEN

❶ DILUTED PULP, RESEMBLING MILK, ENTERS PAPER MACHINE

FINE-MESH BRONZE SCREEN SUPPORTS PAPER DURING FORMATION

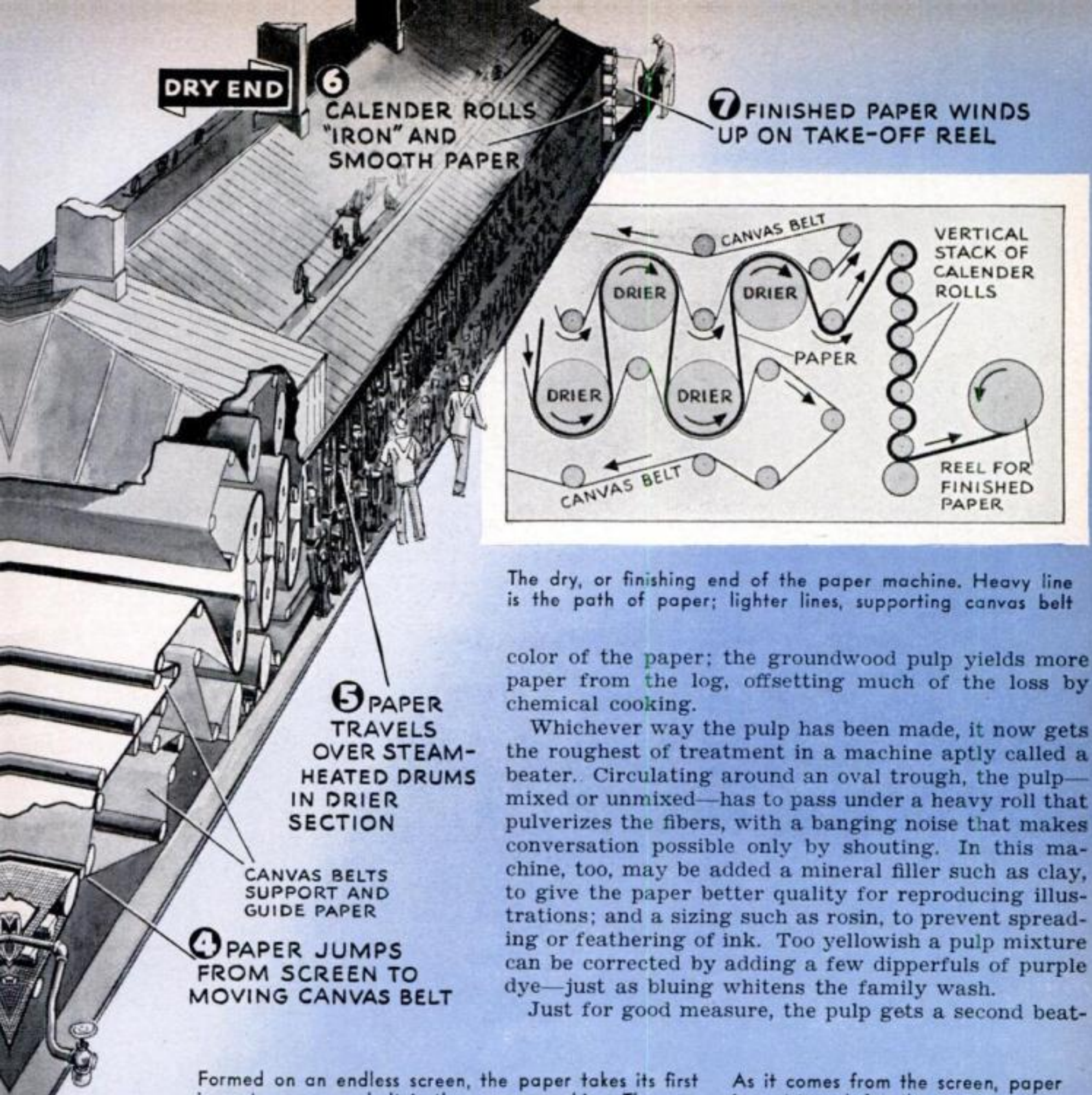
FLOW BOX

ADJUSTABLE EDGE CONTROLS THICKNESS OF PAPER

FILTER SCREENS

WET END

MACHINE OSCILLATES SIDEWAYS TO HELP MAT FIBERS



The dry, or finishing end of the paper machine. Heavy line is the path of paper; lighter lines, supporting canvas belt

color of the paper; the groundwood pulp yields more paper from the log, offsetting much of the loss by chemical cooking.

Whichever way the pulp has been made, it now gets the roughest of treatment in a machine aptly called a beater. Circulating around an oval trough, the pulp—mixed or unmixed—has to pass under a heavy roll that pulverizes the fibers, with a banging noise that makes conversation possible only by shouting. In this machine, too, may be added a mineral filler such as clay, to give the paper better quality for reproducing illustrations; and a sizing such as rosin, to prevent spreading or feathering of ink. Too yellowish a pulp mixture can be corrected by adding a few dipperfuls of purple dye—just as bluing whitens the family wash.

Just for good measure, the pulp gets a second beat-

Formed on an endless screen, the paper takes its first jump to a canvas belt in the paper machine. The narrow strip will soon spread out to the belt's full width

As it comes from the screen, paper is moist and fragile, tearing when it is simply held from the fingers

Operator is pointing to the last of the machine's 32 drying rolls. From it paper passes over his head to calender stack

ing. Then water dilutes it until the milky fluid contains only one half of one percent of pulp. Now it is ready to be transformed into paper by the Fourdrinier machine, a mechanical wonder of industry.

Stretching the entire length of a factory floor, this paper-making machine is one of those fabulous creations that you simply don't believe can work, until it does before your eyes. Its most interesting part, where the paper first is formed, makes up the first third of its length. And the principal working part of this section consists simply of an endless bronze screen, of mesh so fine that it looks opaque except against a strong light.

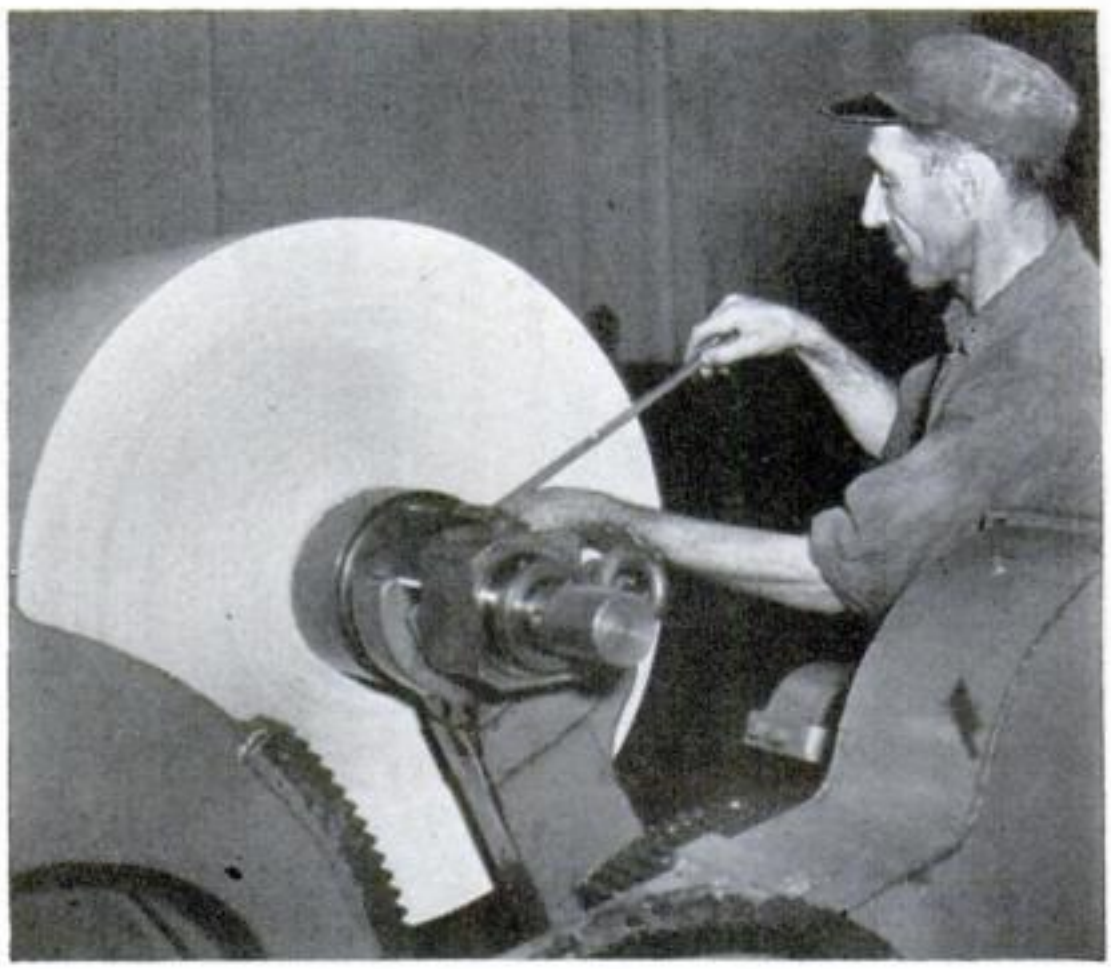
At the brisk walking pace of 300 feet a minute, the upper surface of the screen travels away from the "wet end" or inlet where the fiber-bearing milk pours upon it. An adjustable knife-edge regulates the stream to control the thickness of the paper. At first, nothing seems to happen on the screen. Then it gradually whitens. Flying droplets, alighting on the clothing of workers and spectators, dry into white spots of real paper! Likewise, a moisture-drained sheet builds up upon the screen until a piece can be snatched from the end for inspection.

Still too limp and soggy to be held from the fingers without tearing, it has to be draped over the wrist while a camera lens records its appearance. What has happened on the screen is that the tiny fibers of pulp have intermingled and matted together like felt, as water was drained from them. To assist in this, the screen constantly jiggles from side to side on rocker joints, preventing parallel alignment of fibers that would weaken the paper.

Meanwhile, with a dexterous movement, a machine operator has fed a strip of the newly formed paper across a gap from the screen to a moving canvas belt. Rapidly the strip widens, and in a few seconds the full width of the paper sheet is following—first into "press rolls" that squeeze out some of the remaining moisture, and then into the drier section of the long machine.

Up and down the paper passes over dozens of steam-heated drying rolls, arranged in upper and lower tiers. Here again, canvas belts support it and hold it in firm contact with the revolving cylinders, first on one side and then on the other. Finally

Finished paper is rolled for storage and shipment. Notched stick shows when the roll has reached the thickness desired



the endless canvas belts part company with the paper, now dry and strong, which passes next through a vertical bank of highly polished and steam-heated calender rolls. These give the sheet a smooth finish, as if it were ironed by hand. Coating, and "supercalendering," used in POPULAR SCIENCE'S paper, are optional before the finished paper reaches a take-off reel. Here a workman with a notched stick tells when the roll is full by gauging the thickness of paper it holds. A clanging signal with an iron bar overtops the roar of the machine, and a crew leaps to slice off the oncoming paper and transfer it to a new, empty roll. A crane picks up the finished one, which gets bundled up first in waterproofing and then in a wrapper. A freight car moves up on a spur alongside a loading platform, and the roll is on its way to the consignee.

Now, how about some of the other kinds of paper, and the ways they are made?

For a newspaper that you read and then throw away, high-quality paper would be a needless extravagance. Therefore, newsprint consists chiefly of inexpensive groundwood pulp—plus a small percentage of unbleached sulphite pulp.

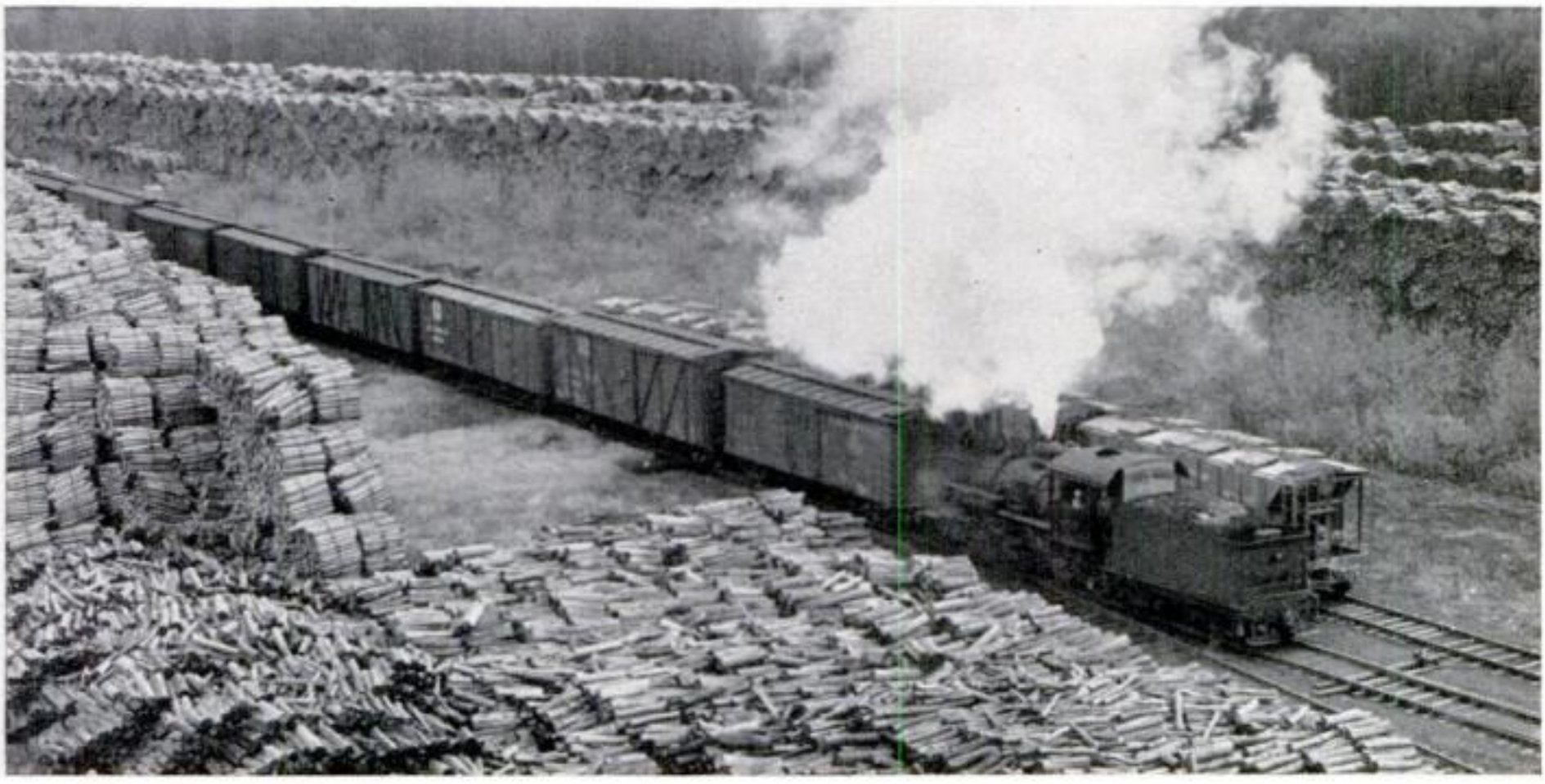
Paper bags, wrapping paper, and corrugated boards are made by the "kraft" method, which takes its name from a German word meaning strength. Like the sulphite process, it is a chemical one, and is technically called the sulphate process. In the first, calcium bisulphite usually serves as the cooking liquor; in the second, a mixture of caustic soda and sodium sulphate.

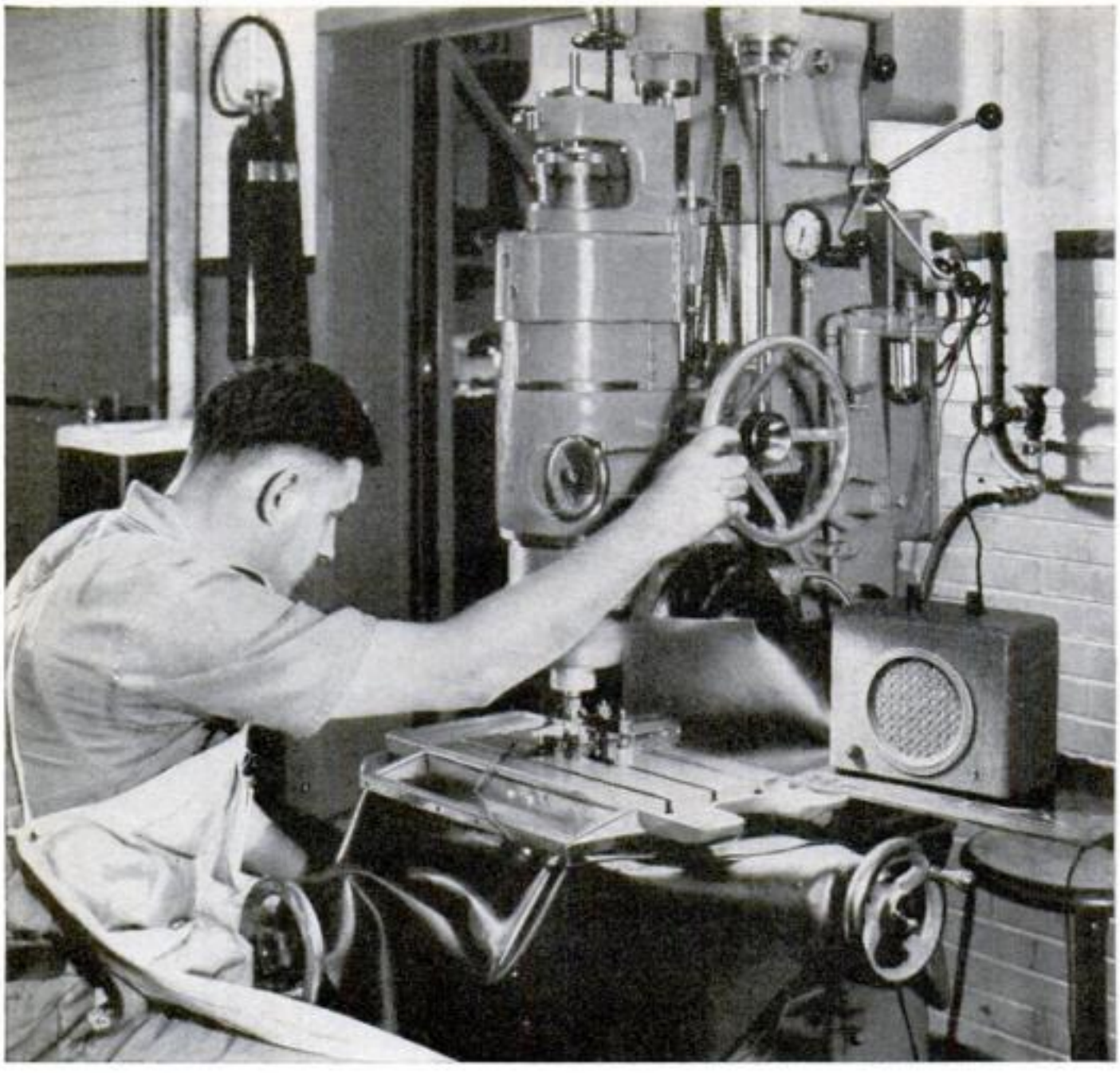
Writing paper and book paper may be made by bleaching the brown pulp of the kraft process. It competes with bleached sulphite pulp, also used for writing papers of the bond and ledger types. Bleached sulphite pulp makes tissue and cleansing papers, as well as transparent glassine wrappings and envelope windows.

Practically all of these papers are manufactured upon the long Fourdrinier machine, with the notable exception of paper board. This is made upon a cylinder machine, in which a revolving drum covered with wire mesh takes the place of the flat Fourdrinier screen.

That is the story of how men take apart a log of wood, and put it together again in new and useful form. But it would not be a complete story without a glimpse into the paper mill's laboratory, where scientific instruments apply strange tests to sheets of every description. For example, magazine paper should be opaque enough to keep printing on one side from showing through on the other. A sample goes into an instrument called an opacimeter, where a light beam of known intensity plays upon it. At the opposite side, an electric eye connected to a meter tells the story. To test for porousness, another instrument determines how much air can be blown through a sample. Additional qualities important in printing, such as surface smoothness and resistance to tearing, are determined by delicate apparatus. In this way, the quality of paper under manufacture may constantly be checked. Moreover, important improvements on current processes are being developed for the future.

In the yard of the paper mill mountains of logs await their turn to be made into paper for newspapers, magazines, or books. The four-foot length into which they have been cut is the standard size for pulp





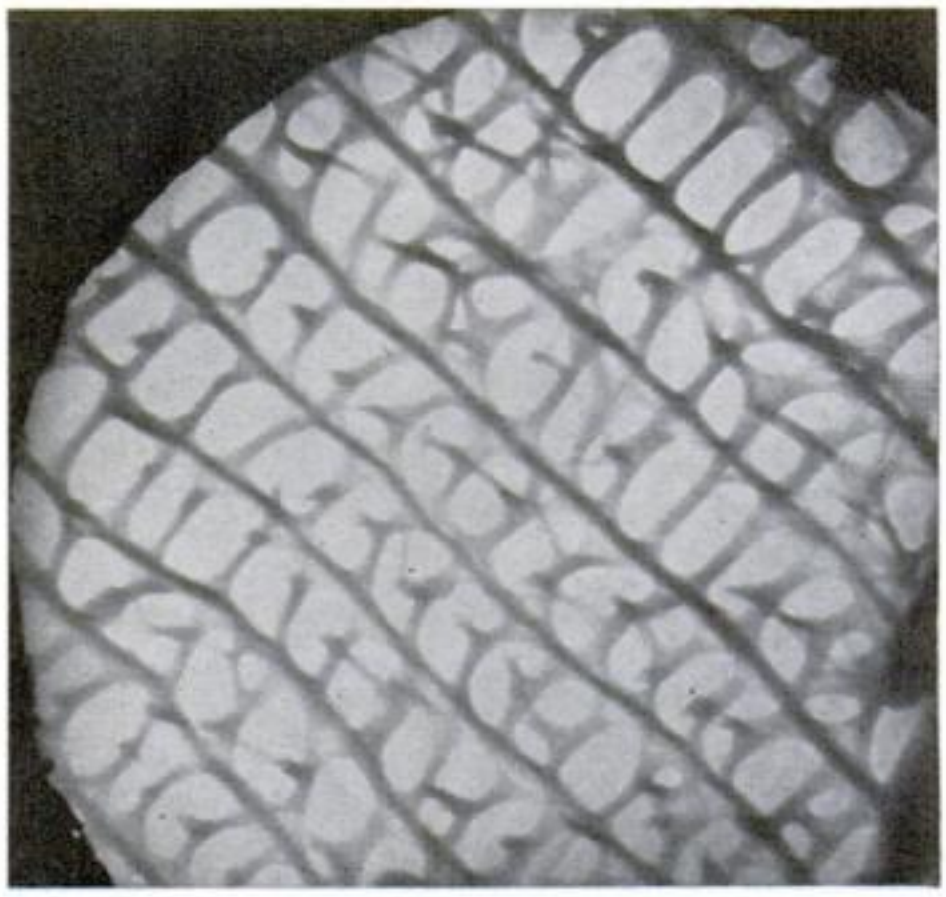
How heavy does the cut sound? Boring minute holes at a speed too fast for the eye to follow, machine operators are guided by the pitch of the sound which is picked up and amplified by an "electric ear"

High-Speed Boring Guided by Amplified Sound Instead of Sight

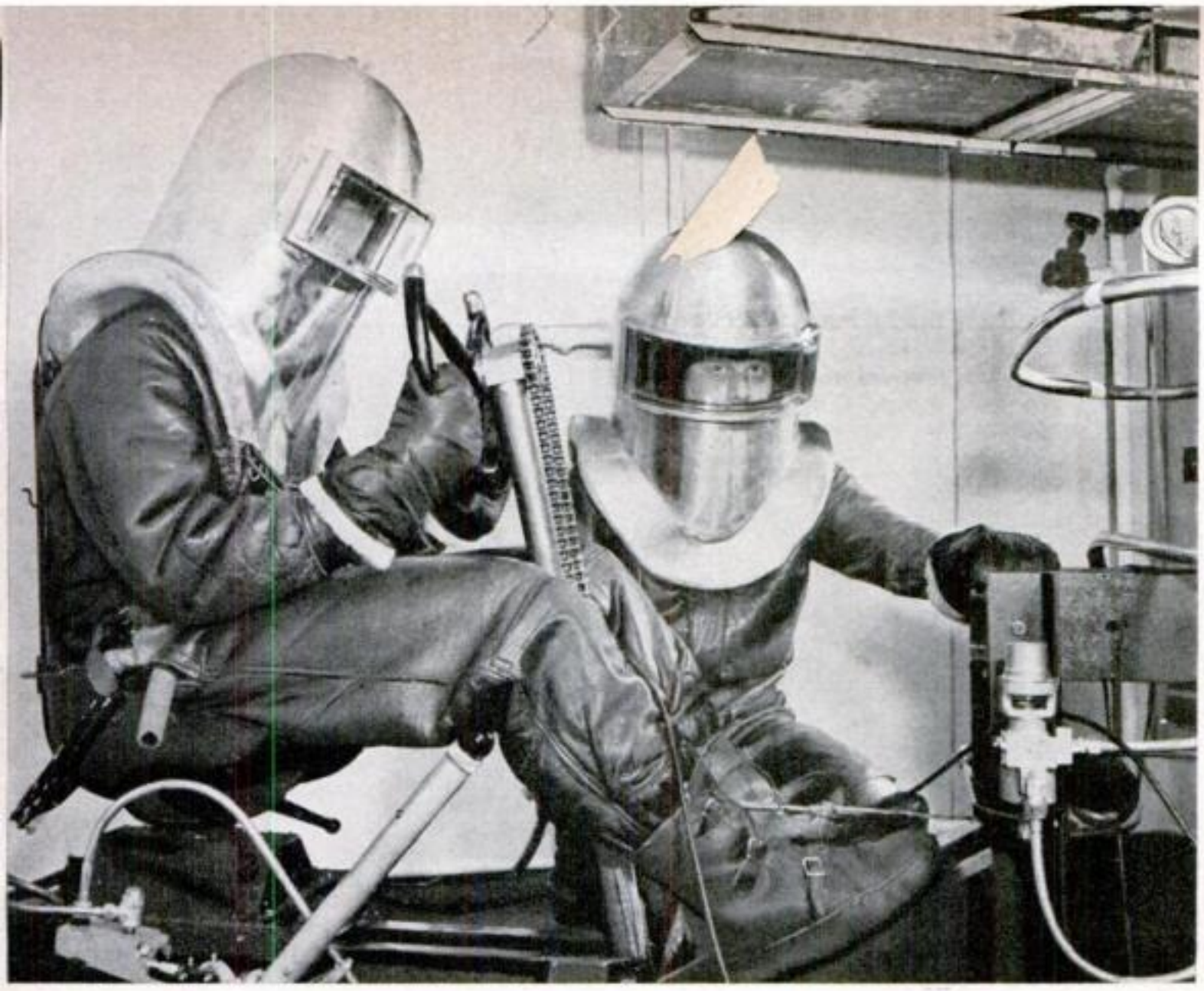
AN "ELECTRIC ear" guides the operator of a high-speed machine for boring in hardened steel holes of a diameter down to twenty thousandths of an inch. The tiny grinding quill is driven by an air spindle at speeds as high as 75,000 revolutions a minute—too fast to be followed by eye. An electric system picks up and amplifies the whine of the cutting edge. By listening to the pitch, a practiced worker can easily tell whether the cut being made is light, heavy, or intermediate.

New Electron Microscope Reveals Insect Structure

WHAT the gossamer fabric of a butterfly's wing looks like, when magnified thousands of times, is shown at right. A small part of just one of the tiny colored scales that overlie the wings like shingles covers this section, pictured with a super-powerful RCA electron microscope. In other insects, the instrument also reveals delicate structures never before seen by entomologists. It not only shows the hoops that reinforce a mosquito's windpipe, but also spines on them less than a quarter-millionth of an inch long. The electron microscope enlarges objects up to 100,000 diameters.



A section of butterfly's wing as viewed in the microscope



Wearing fantastic fleece-lined suits and aluminum helmets, research men at Douglas Aircraft Co., Santa Monica, Calif., test plane parts at low temperature

The altitude pressure chamber below can "go up" to the equivalent of an elevation of 55,000 feet to test effect on flyers

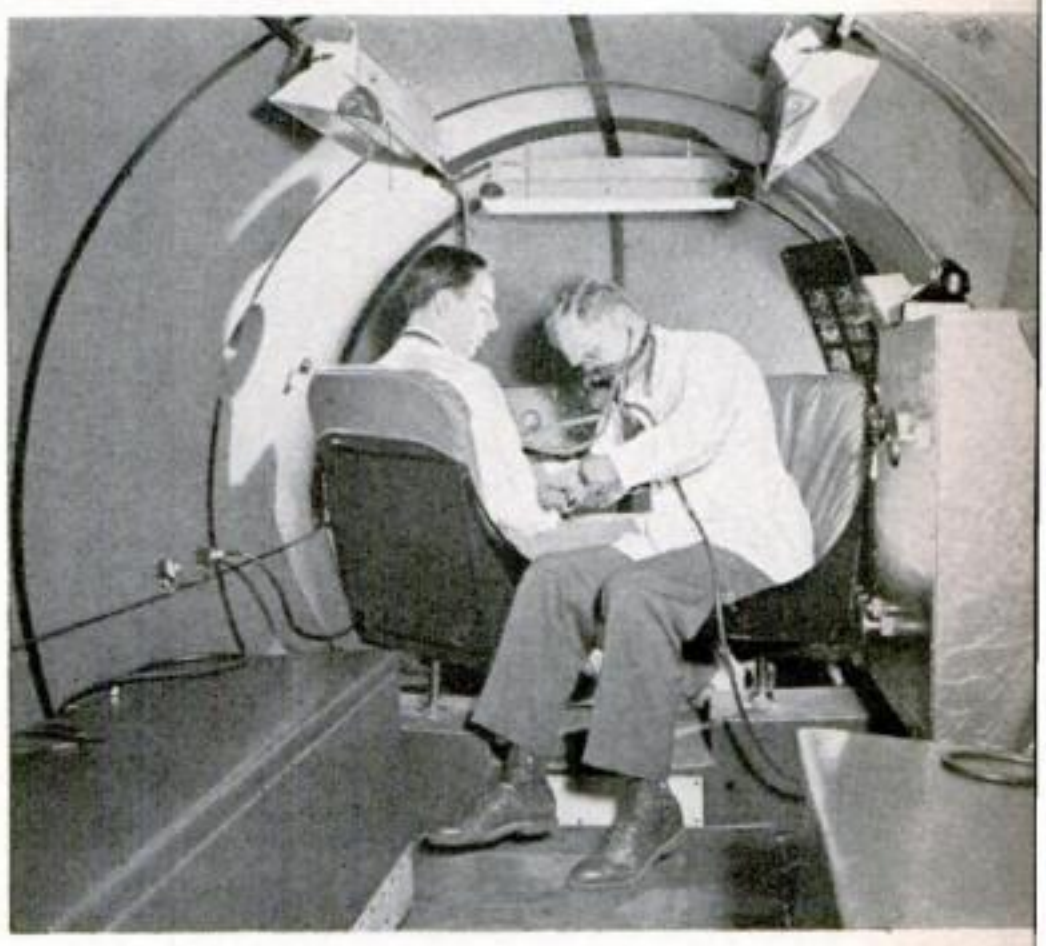
"Cold Room" Tests Men and Materials for High Flying

TO TEST the effects of extreme cold on high-flying planes and aviators, engineers of the Douglas Aircraft Company, at Santa Monica, Calif., have constructed a "cold room" in which they are able to subject men and materials to temperatures as low as 104 degrees below zero.

At 35,000 feet, they point out, there is an almost constant temperature of 67 below zero Fahrenheit. Here the metal skin of a plane shrinks, loosening its paint and camouflage; lubricating oil congeals, rubber becomes brittle, and men are easily fatigued.

In one room at the Douglas plant, engineers test fuel, oil, and hydraulic systems; controls, structural parts, insulation, heating, windshield de-icing devices, and bearings. Adjacent to this test chamber is another room fitted out like the cockpit of a plane, which can also be chilled to subarctic temperatures. Here aviators are tested for their reactions to high altitude and cold.

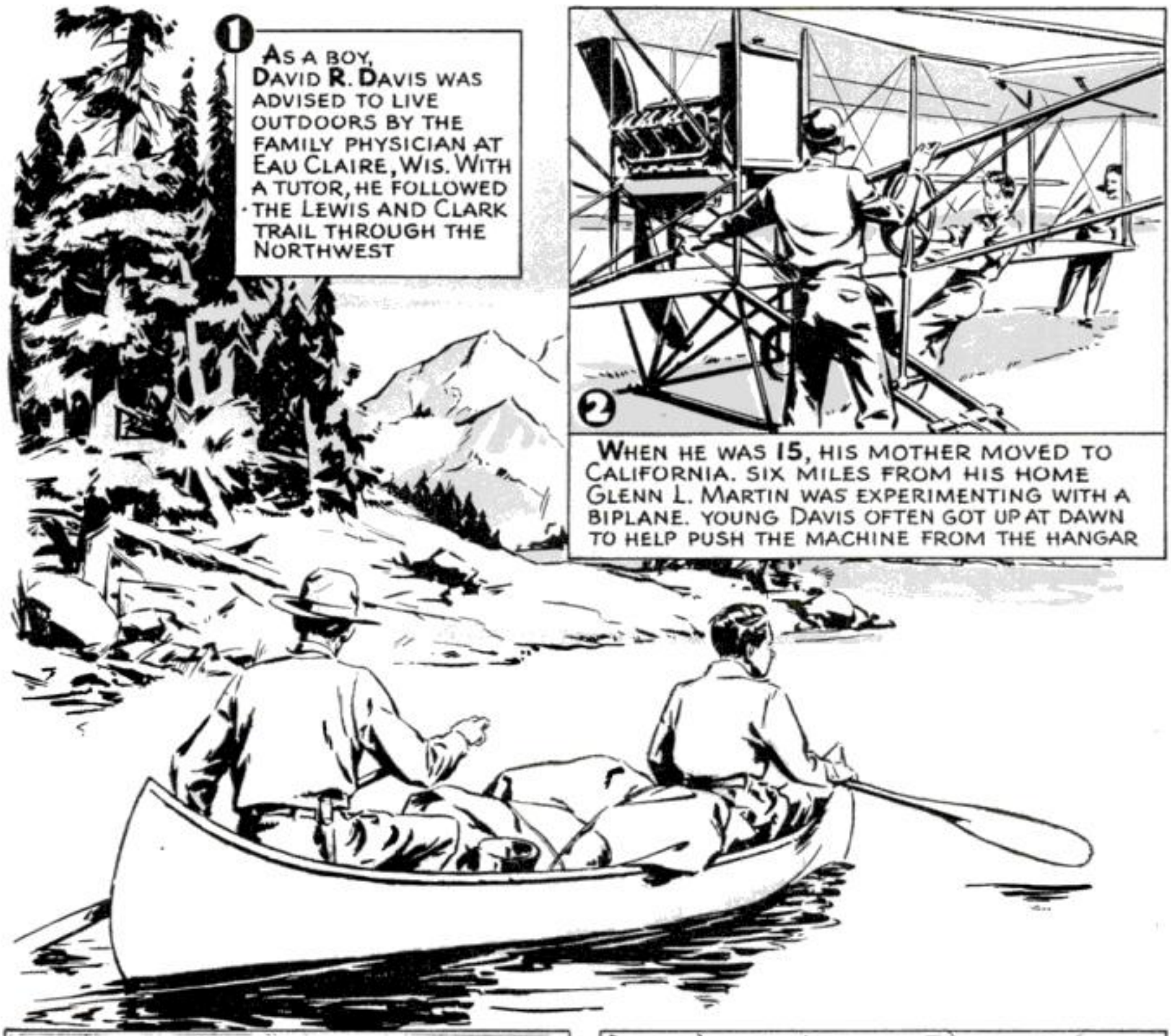
The men who conduct these experiments wear sheepskin-lined leather suits and helmets made of spun aluminum. The two chambers are cooled by a combination of dry ice and methyl alcohol.



Materials below show the results of exposure to extreme cold. Some rubber hose connections crack, split longitudinally, and virtually disintegrate

Here's My Story

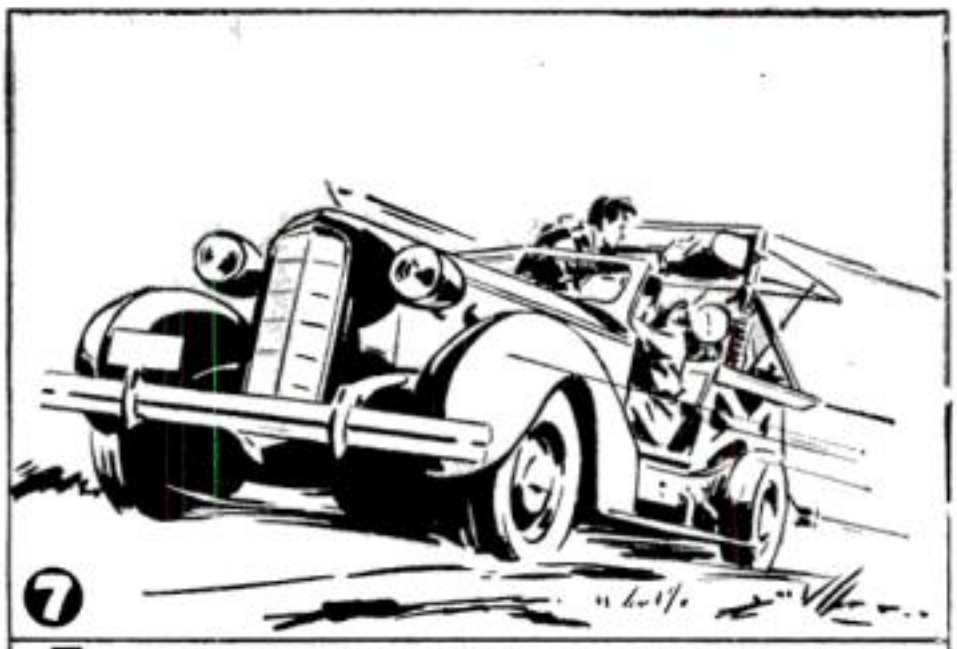
HIS COMEBACK HAS REVOLUTIONIZED AIRCRAFT WING DESIGN



THE CAREER OF
DAVID R. DAVIS

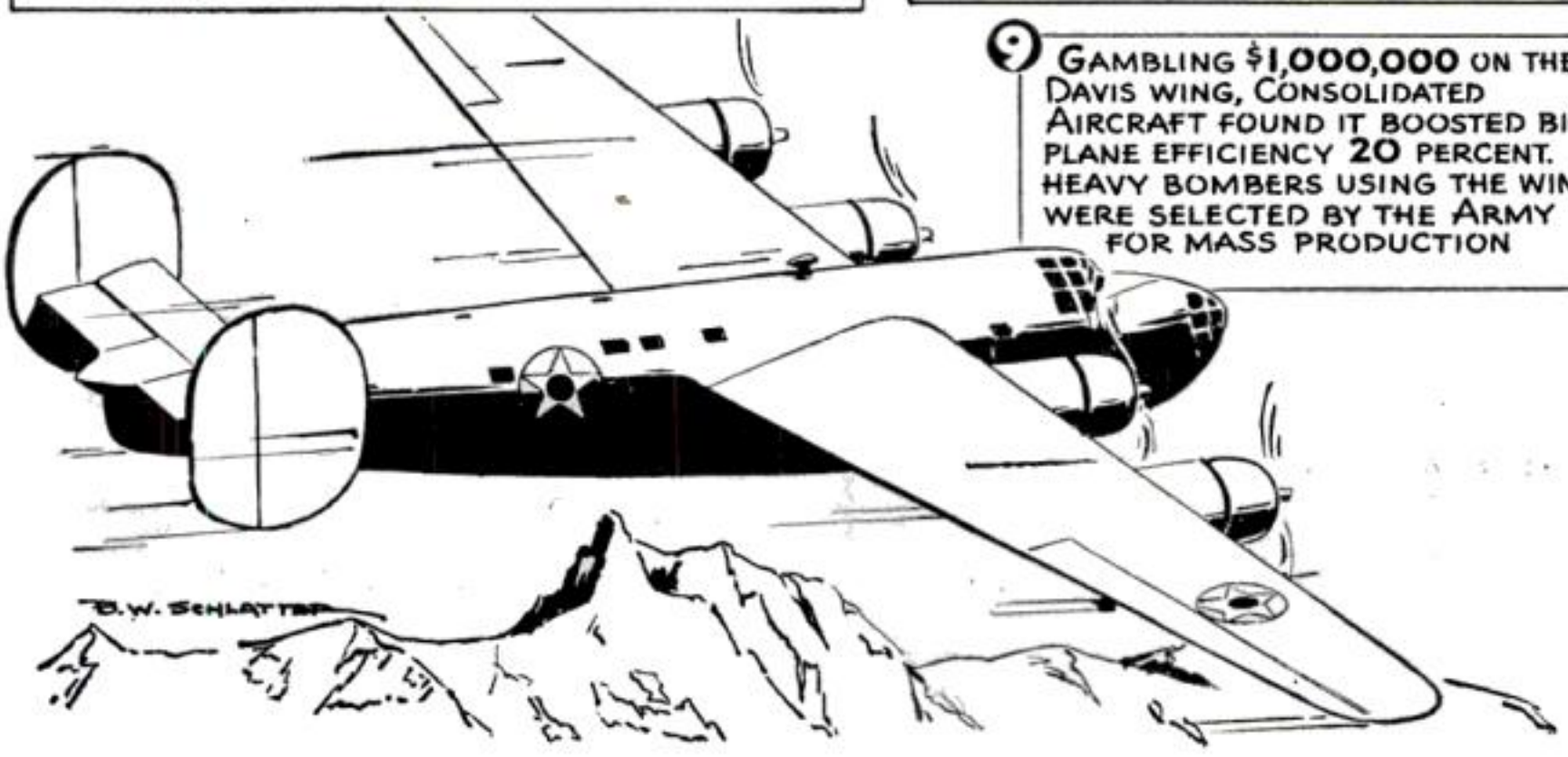
IN 1920, WITH DONALD DOUGLAS, HE STARTED AN AIRPLANE COMPANY. LOSING HIS FORTUNE IN THE COMPANY AND IN THE 1929 CRASH, HE SPENT SEVERAL YEARS WORKING ON AN ADJUSTABLE-PITCH PROPELLER

WHILE SUPPORTING HIS WIFE AND DAUGHTER ON A $5-A-DAY JOB, HE SPENT HIS SPARE TIME WORKING AT THE KITCHEN TABLE, INVENTING A NEW-TYPE AIRPLANE WING



TO TEST A SECTION OF HIS WING, HE MOUNTED IT ON A BORROWED CAR AND RACED 90 MILES AN HOUR DOWN LONELY ROADS. HOMEMADE INSTRUMENTS REVEALED IT WAS SUPERIOR TO CONVENTIONAL WINGS

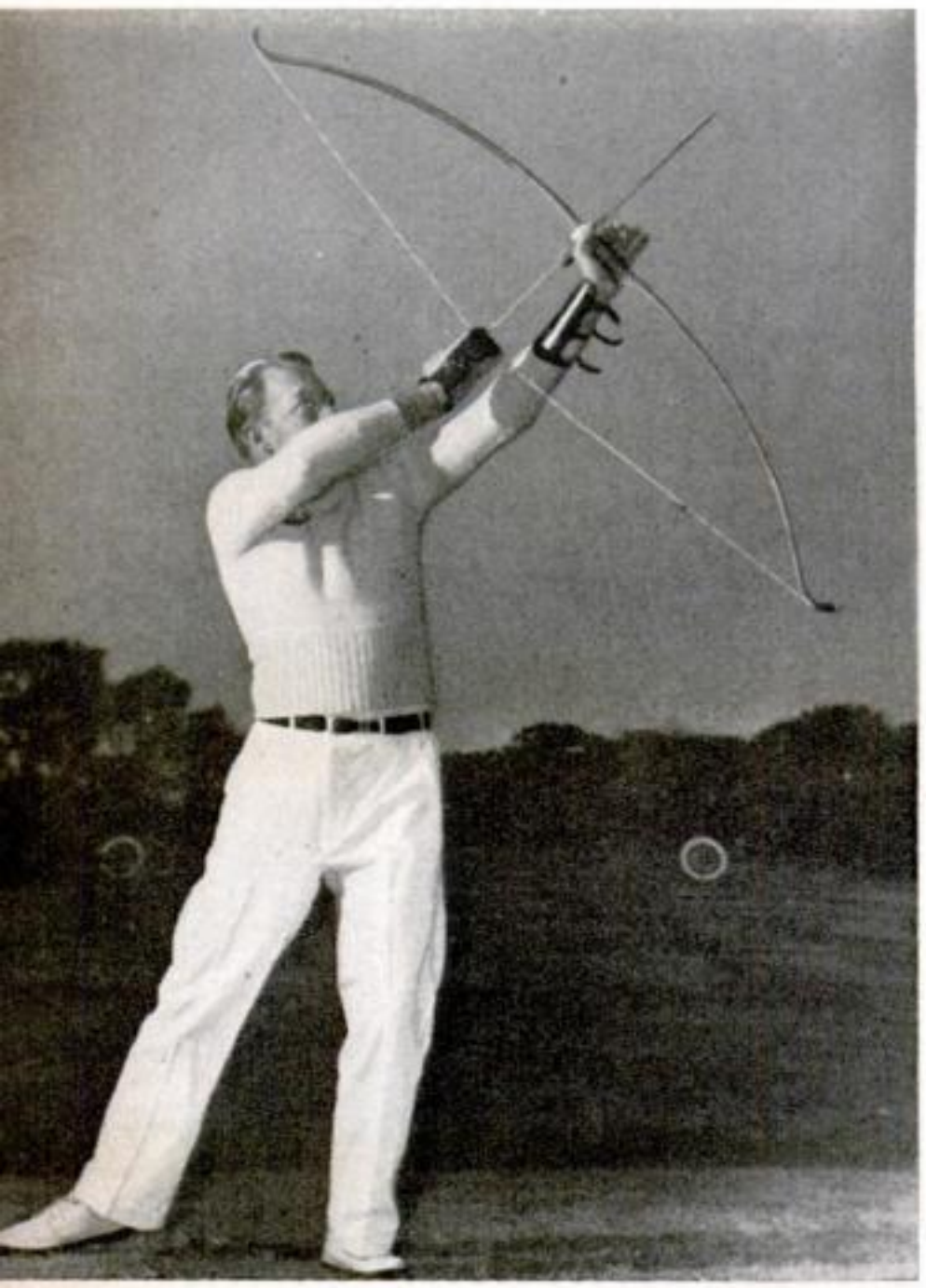
WHEN THE WING WAS TESTED AT THE CALIFORNIA INSTITUTE OF TECHNOLOGY, IT WAS SO EFFICIENT THE SCIENTISTS TOOK THEIR TUNNEL APART SEEKING SOME SOURCE OF ERROR



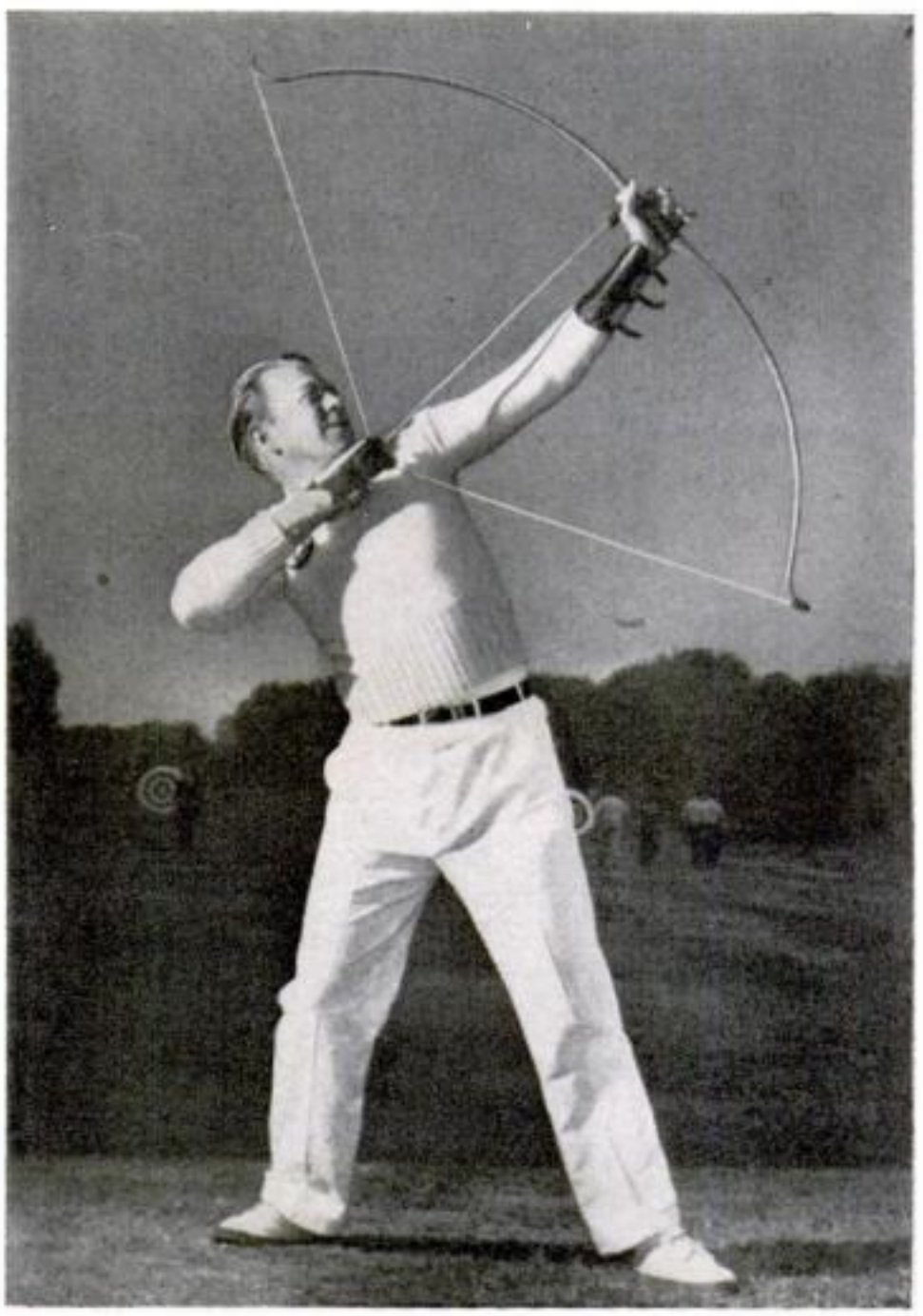
9 GAMBLING $1,000,000 ON THE DAVIS WING, CONSOLIDATED AIRCRAFT FOUND IT BOOSTED BIG-PLANE EFFICIENCY 20 PERCENT. HEAVY BOMBERS USING THE WING WERE SELECTED BY THE ARMY FOR MASS PRODUCTION

HOW IT IS DONE

Secrets of



A. Vanderkogel, president of the Metropolitan Archery Association (New York), demonstrates the regular style of flight shooting for distance



Leaning slightly backward, the archer aims his arrow upward at an angle of 43 to 44 degrees from the horizontal to get the ideal flight trajectory

WHEN a flight archer pulls his heavy bow and sends an arrow on its way he has little interest in bull's-eyes. It is yards, not points, that he is after. He is one of the Babe Ruths and Joe DiMaggios of the archery game; he is out to "slam it over the fence" and the farther it goes the better he likes it. Distance is his sole objective, and he is fast achieving new and almost unbelievable marks. Ten years ago, an arrow flight of 437 yards was considered tops; today, the unofficial record stands at 768 yards, the official at 517.

This improvement is far from haphazard; it represents years of tinkering and trying carried on by mathematically minded enthusiasts and strong-armed sportsmen who have built their own equipment. For competition, they have a mark to shoot at, for four centuries ago, when archery was the national sport of the Turks, flight shots often exceeded 900 yards, well over a half mile. Modern archers haven't yet equaled that, but the flight experts are convinced they are well on the way. They have already outstripped their English counterparts of Robin Hood's day, and the American Indian, feared as he was by the early settlers, never was any great shakes as a distance shot.

Flight archery, as distinct from the familiar sport of the target range, is itself divided into two fields—"free style" and "regular style." In regular-style shooting, the archer stands erect, leaning slightly backward, and aiming his arrow skyward at an angle of 43 to 44 degrees. As he releases the shaft he springs forward, giving the arrow an extra push that may add precious feet to the length of its flight.

The free-style flight archer lies on his

the Flight Archers

As he releases the shaft, he springs forward, giving the arrow an extra push that may add feet to the flight. In this style of shooting, body rhythm is an important factor

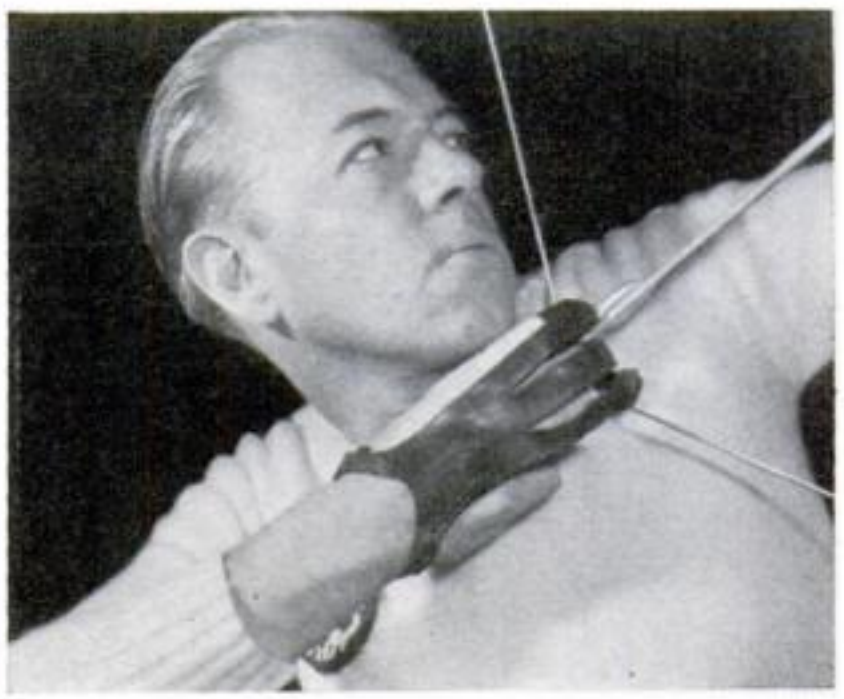
SHOOTING FOR DISTANCE WITH A BOW AND ARROW IS A SCIENTIFIC SPORT

back, cocks his legs, braces the bow with his feet, yanks on the bow string with both hands, and lets her ride. He gets the extra push at the start of the flight with his feet, which are lashed tight to the bow by straps. It is the free-style archer who gets the greater distance.

The average flight bow is about twice as wide as a target bow, to give it more fling, and considerably shorter. The typical regular-style flight bow runs from four feet eight inches to five feet two, while the free-style bow usually is from five feet to five feet six. Target bows are from five feet six to five feet eight. The most noticeable difference between the bows is in their "pull," the amount of effort necessary to bring the bowstring to the "draw" position from which the arrow is released. To draw a man's target bow takes about as much strength as lifting a 40-pound weight. The regular-style flight bow takes nearly twice as strong a pull—70 pounds. The foot bow is even harder to draw. A 125-pound pull is average, while some need pulls as high as 250 pounds.

Flight arrows are much fatter in the middle than at either end. The reason for that is a curious principle of physics that a crushing weight pressed down evenly on the top of a column will cause a break, not at the top or the bottom, but in the middle. This can be tested by rolling up a piece of paper and pushing down sharply on the top. It will bend in the middle. Applied to flight archery, this means that an arrow which is made too light will snap in half as soon as the bowstring is released. Inertia is pushing back at one end and the string shoving forward at the other, and the

This is free-style flight shooting, in which the archer lies on his back with the bow strapped to his feet. The bowman is Ken Wilhelm, of California, who recently made an unofficial free-style shot of 2,305 feet, more than 768 yards



REGULAR-STYLE FLIGHT SHOOTING calls for a bow with a heavier draw than target tackle. To permit pulling the head of the arrow past the belly of the bow for maximum draw, an overdraw—a trough of leather or brass with a "carpet" of sealskin is attached to the handle. Bowstring is hand-woven of Irish linen, so light that it often explodes on the first shot. Archery glove protects right hand

force is sometimes too great. However, flight arrows are light, weighing only from 200 to 300 grains compared to 300 to 500 for a target arrow. They run about 26 inches long; target arrows from 25 to 28.

The strings of flight bows are a sort of paradox. Although they must stand up under a pull two, three, or even four times as heavy as that borne by a target bowstring, they are only half as heavy. The reason is that flight archers have found that even so slight a thing as a lighter bowstring can add ten yards or more to a shot. When the bowstring is released at full draw, its weight, no matter how light, acts as a drag on the recoiling arms of the bow. The heavier the string, the slower the bow returns to position, and the slower the bow recoils, the weaker the arrow is shot out. The archer's rule of thumb is that "one-third the weight of the string is tacked on the arrow."

To reduce friction, talcum powder is smeared on the arrow. Powder also lubricates the overdraw, the sealskin carpet of which is laid in such a way that the hairs point in the direction of flight. Every ounce of energy counts

Osage orange wood is used for most flight bows. It grows abundantly in the central and southwestern parts of the country, and is common enough in those regions to do duty as fence posts. The most ardent of the flight shooters insist that their billets of Osage orange be seasoned not less than ten years, with the bark on and both ends painted or paraffined, before carving of the bow begins. Three years is considered the minimum for seasoning.

When ready at last, the bark is removed and the sapwood is cut away with a drawknife. Since it is practically impossible to get a satisfactory five-foot length, most of the flight bowyers take a three-foot length, saw it down the middle with a circular saw, and then link the two lengths together with a W-shaped fishtail joint. A circular saw cuts out the teeth of the joint, and glue binds the two parts together. This joint is placed in the part of the bow intended to serve as the handle. The handle is always motionless, so there is no bow movement there to weaken the joint.

The post is now prepared for carving

by drawing a guide line down the center, and then on the top, bottom, and sides to indicate the dimensions desired in the finished bow. A plane cuts away the excess wood. Progressively from there on a drawknife, rasp, file, and sandpaper are used to bring the bow to its final dimensions. The finer tools are brought into play as the bow nears its final form, in order to guard against cutting the grain and starting splinters that might later cause the breaking of the bow while in use.

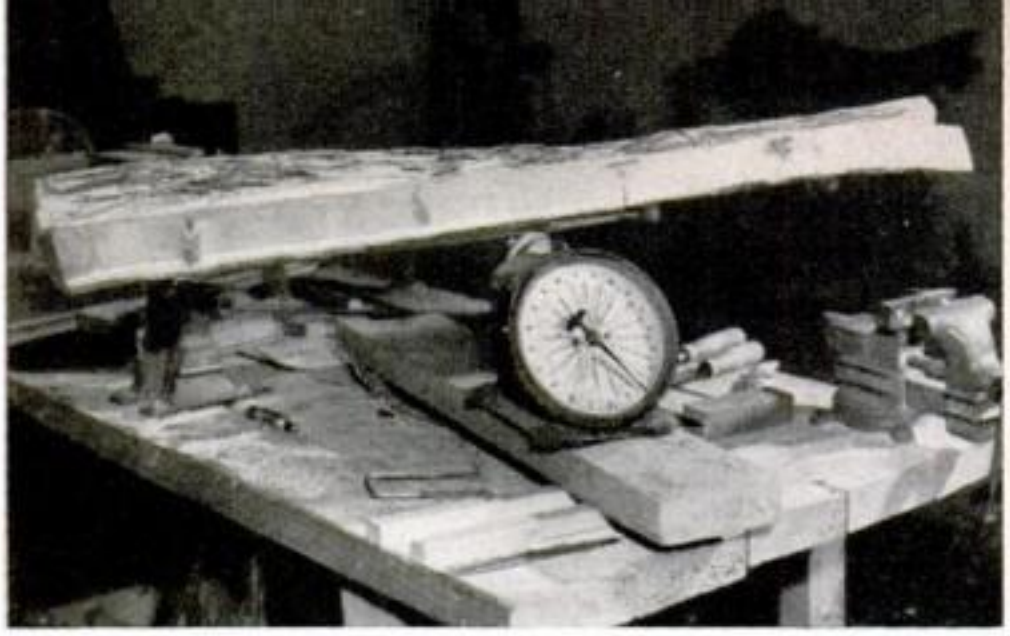
The handle in the center of a typical flight bow is from eight to 12 inches long, two inches thick, and one inch wide. On either side, the limbs start at a width of 2½ inches and taper in straight lines to a quarter of an inch at the tips. They are from 1½ to 1¾ inches thick from the handle to a point two-thirds of the way to the tip, and from there taper to a quarter of an inch at the tip.

The handle is only two-fifths the width of the limbs at the middle part of the bow. This cut-out effect permits the arrow to slide past with the least possible deflection. Since the bowstring bisects the bow, it is impossible to keep the arrow from rubbing at least a small bit. This is unfortunate for distance shooters for it makes the arrow wabble for the first dozen yards, and if too pronounced, would slice it to the side. One reason Indians never made great distance shots is that their bows did not have cut-out handles. The center of the bow was as fat as every other part of it. The result was a sluggish weapon with a penchant for shooting to the side. Unfortunately for the pioneers, the Indians managed to make up for this at close range by changing their aiming point.

The carved bow still is not finished. It must have backing to keep it from breaking in two when subjected to the great drawing strain. Flight bows are "95 percent broken" when they are at full draw, the archers say. Another five percent of strain and the bow would shatter. Accordingly, the Achilles' tendon of cattle, the bundle of sinew on the back of the leg above the heel, is glued to the back of the bow, a trick of the Middle Ages not yet improved upon. These tough fibers can withstand as much as 22,000 pounds pull per square inch. Modern bowyers pound out these tendons with a wooden mallet until they lie flat and stringy. These strings, each about four inches long, are placed side by side in hot glue on the back

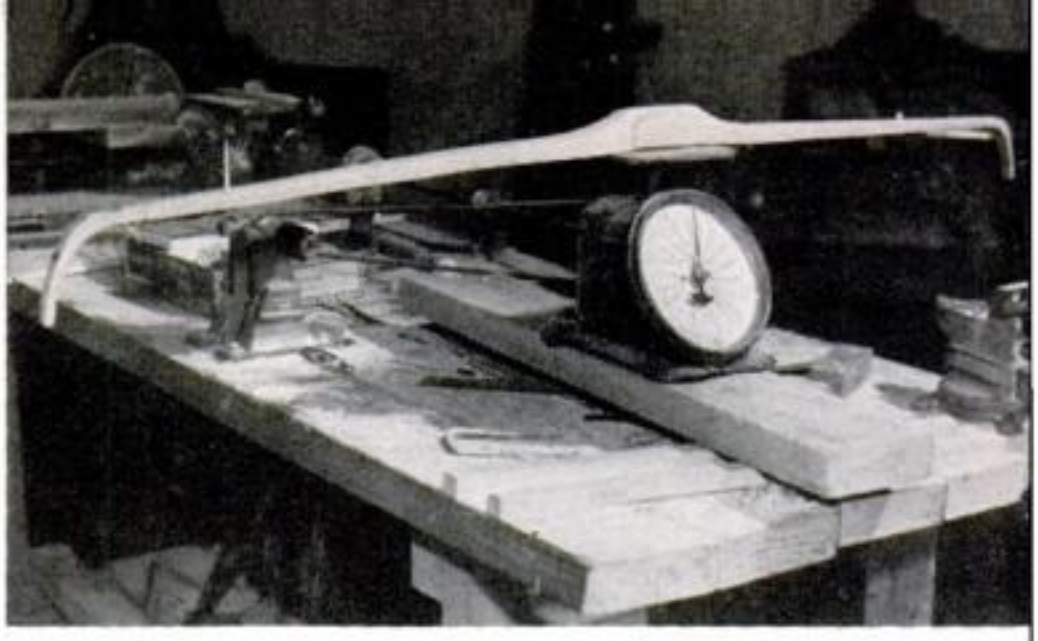
Full draw for a free-style shot. Note the straps that hold the bow to the feet. Here the overdraw is built into the handle. Using both hands, as seen in the lower photograph, enables the free-style archer to get a pull of 125 pounds or more, compared with 75 to 80 for a regular-style bow

Ken Wilhelm draws the foot bow while his brother Walt sights to give him the angle. As the arrow is let fly, a kick with the feet gives it a final push like that in regular-style work



8 lb.

Wood for making a regular-style flight bow weighs about eight pounds at the start. There is a piece for each limb of the bow



1 lb.

How it looks at the finish. Some seven pounds of wood have been removed. Limbs are reflexed, or bent backward, recurved at ends

of the bow, the tips of the successive series overlapping for greater strength, and bound with cloth until dry. The very application tightens and strengthens a bow. In fact, some woods cannot stand the strain as they shrink.

The best wood for flight arrows, by consensus, is Port Orford cedar, a wood grown in a patch of a few hundred square miles on the West Coast. It is light, straight-grained, easily worked, and spiny. The last quality helps resist the breaking force at release and makes the arrow fly true. A square stick is planed to an octagon, and then rotated in a chuck and burnished round.

The vanes are mere nubs, each with an area only half that of a dime. Celluloid is used instead of the target archer's feathers. The vanes are big enough to keep the arrow going forward, though not enough for accurate shooting.

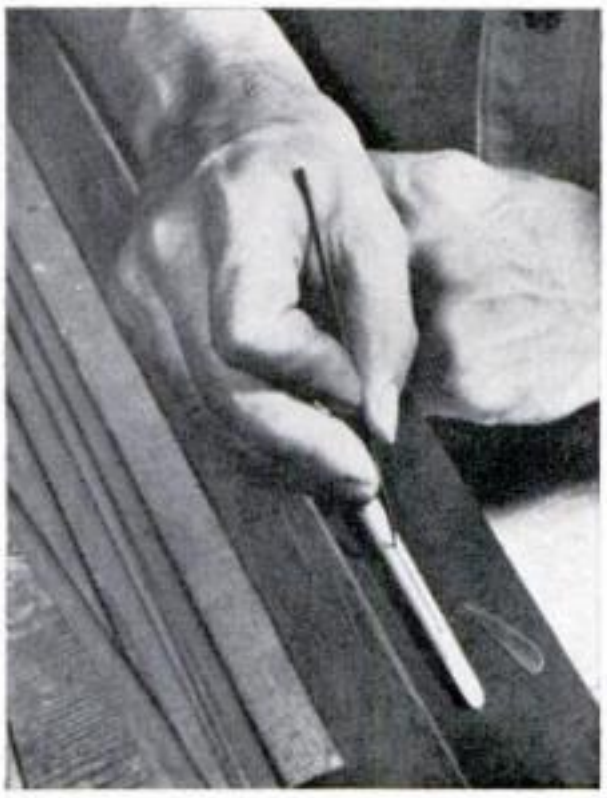
Alert to every chance for another few yards, flight archers are experimenting now with duralumin arrows. This highly polished metal has practically no "skin friction" with the result that an arrow made of it can be expected to slide through the air for just a little bit more.

The bowstrings are a science in themselves. Almost all are made of flax—54 threads or less for flight bows, and over 100 for target bows. The threads are wound into strands around nails in a board as far apart as the length of the string desired. Three strands are each rubbed hard in caked beeswax, and then wound into the string. Many flight shooters spend more than an hour on a string, knowing that if minute care is taken in winding to leave no kinks or uneven spots, a lighter-than-usual string is possible. The reason, of course, is that a kinky or uneven string must have extra threads to compensate for the weak spots produced by unequal distribution of the strain.

Despite this labor, they arrange to have their bowstring break on every shot, and break at a particular moment—one inch before the string returns to the brace position, that in which the bowstring was before the draw began. Dr. C. N. Hickman, engineer for the Bell Telephone Laboratories in New York, and a student of the science of flight shooting as a hobby, worked this out for the archers. He found that strain on a string increases sharply instead of decreasing as the string snaps back to the brace position. One inch from draw the strain was 130 pounds, and at brace it leaped to 210 pounds. That meant that a 44-percent heavier string was necessary to give the arrow the final inch of push. By additional tests, he determined that only 1½ percent of the arrow's energy was put into it by that final inch, less than the weight "tacked onto the arrow" by the heavier string. So

MAKING THE FLIGHT BOW. Blanks for the two limbs are carefully joined at the handle. This section, two inches deep and eight to 12 inches long, does not bend. The recurved tip, being finished at the right, has a groove along its outside curve in which the string lies. This curve gives the strength of a long bow at full draw, combined with the speed of a shorter bow after the arrow has been released

At the right, an arrow turning in a chuck is being smoothed down with a sanding block. Flight arrows are thickest in the middle to withstand compression, taper toward the ends. Port Orford cedar, from the Pacific coast, is the favorite material. It is straight-grained, easily worked, and spiny



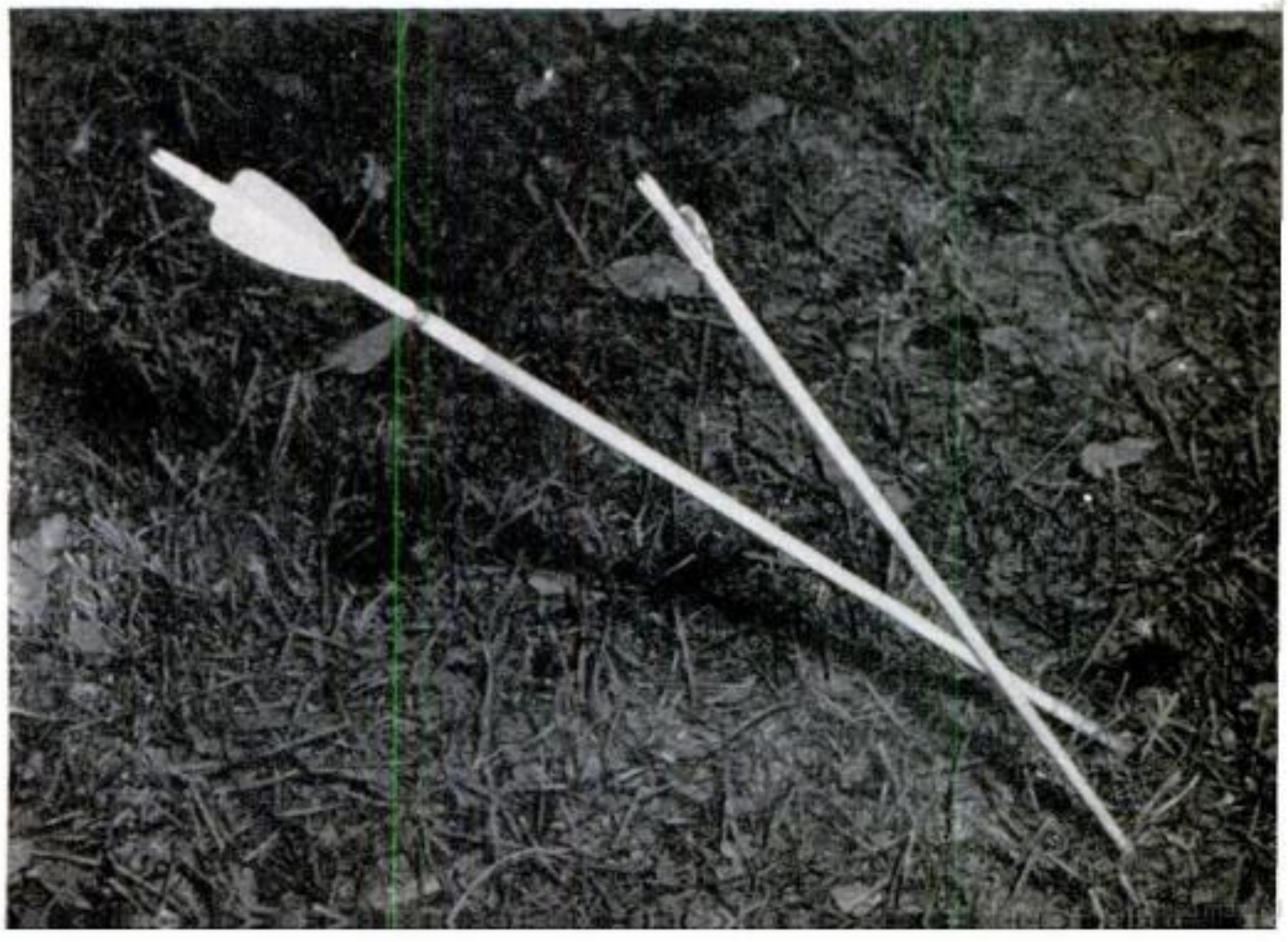
At the left, a flight arrow is being slit to receive one of the celluloid vanes that are used instead of feathers. Shafts for distance shooting are thinner and usually shorter than those for target work. No metal tip is employed, but the end of the wood is sharpened to stick up in the ground

the flight archers' research scientist decreed for them that the strings should break an inch from draw.

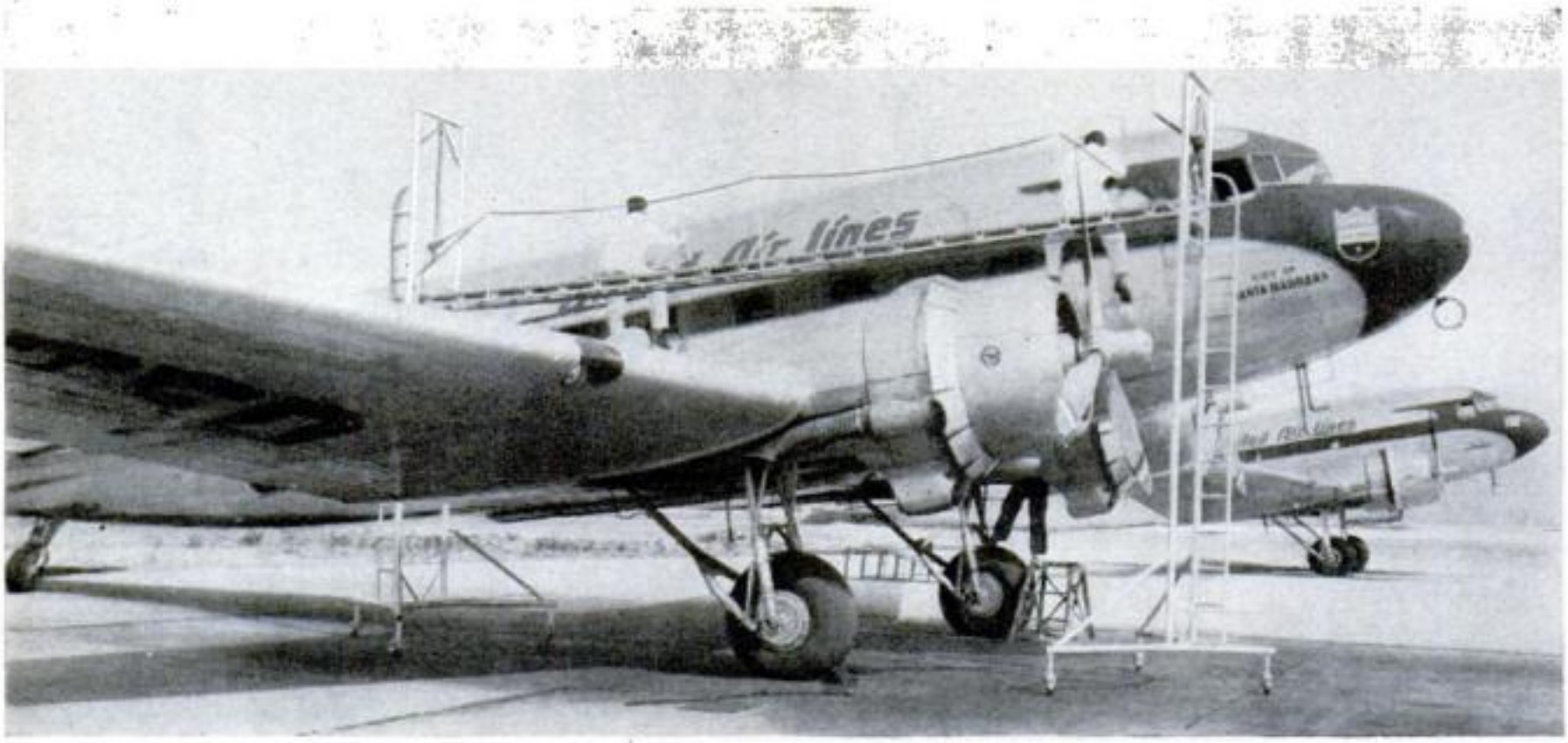
One secret the moderns have been unable to penetrate is the use of the horn of the water buffalo as the lining of the belly of the bow. When a wooden bow is drawn, the belly is subjected to a severe squeeze and the fibers are often crushed. Dr. Paul E. Klopsteg, of Chicago, sent to the Philippines for some of this horn. When he tried it, however, it broke. Improper humidity was thought to be a possible explanation.

The importance of proper humidity was demonstrated recently when a mediocre bow, which had never shot better than 450 yards in a damp Middle Western section, set a national record on the West Coast. It had dried out properly there. Moisture in the air has so great an effect that a muggy day can make bows weak and flabby, spoiling them temporarily.

Flight archers sometimes are sensitive about people thinking they have applied an inordinate amount of time and study to a useless hobby. They insist, however, that it has not been wasted effort. They claim a large share of the credit for the great advance in all types of archery equipment made during the past ten years, citing particularly the fact that men's bows, which ten years ago needed a 50-pound pull on the average, now need 20 percent less exertion with the result that greater accuracy is possible on the target range.



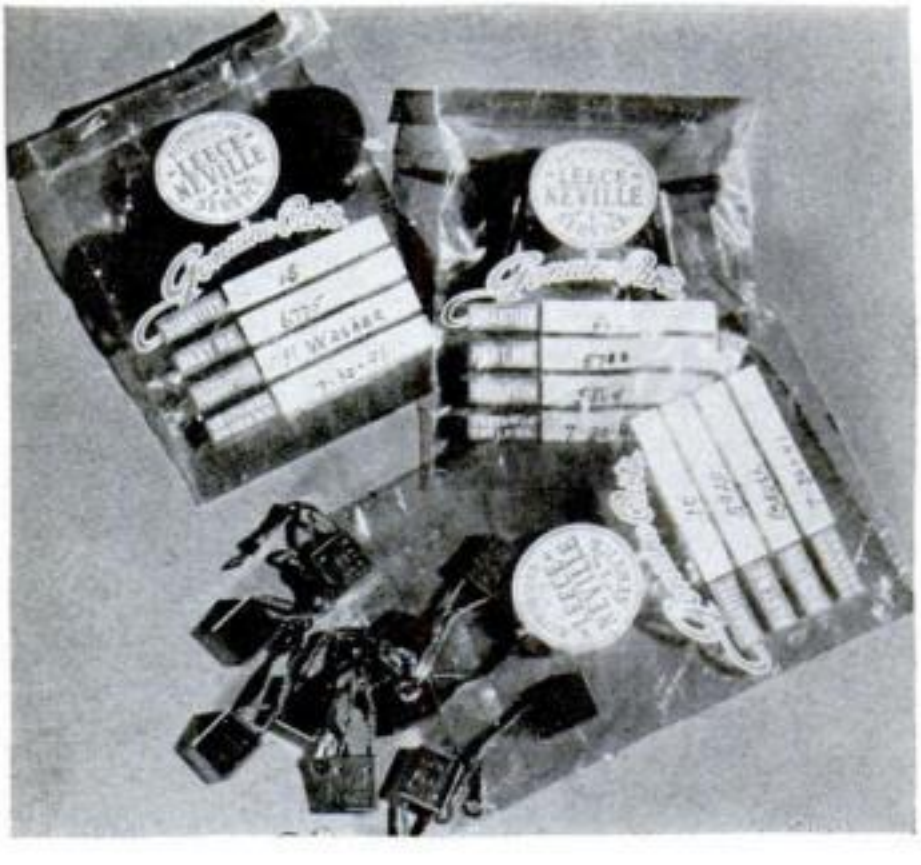
Flight archery differs from target work even in the way the arrows strike the ground. With its comparatively level trajectory, the target shaft lands nearly parallel to the ground, while the flight arrow stands nearly vertical



Movable Platform Employed in Cleaning Airliners

UNITED Airlines engineers have designed an adjustable, mobile stand on which mechanics can reach any external part of an airplane. It consists of two caster-mounted upright sections of steel tubing, each 12 feet high, and an aluminum platform, 25 feet long and 20 inches wide, which the mechanics can raise, lower, or tilt to an angle of 20 degrees without descending. The stage can be placed over a wing, nacelle, propeller, or a section of the fuselage for washing, polishing, inspection, and installation or removal of such parts as de-icer boots.

Sitting above a section of the plane, a mechanic can work at any level on the adjustable stand. The lever and chain hoist arrangement shown permits raising or lowering the platform with hardly an instant's delay



Moistureproof Bags Made for Small Machine Parts

CELLOPHANE packages, now being made for manufacturers of small machine parts, have on their face a series of white panels printed in a special ink which will take pencil or hand-stamped identification marks. The packaged product also can be seen easily through the transparent material. The openings can be crimped shut with a set of heated jaws, thus making any tampering with the contents subject to immediate detection. The cellulose film is moistureproof and affords protection against rust during shipment, storage, or display.

Brain of an American field army in maneuvers: one of the trailer units of a mobile headquarters from which the movements of 250,000 men are directed. Above is a telephone switchboard that links it with troops in action. Below, draftsman working in map trailer

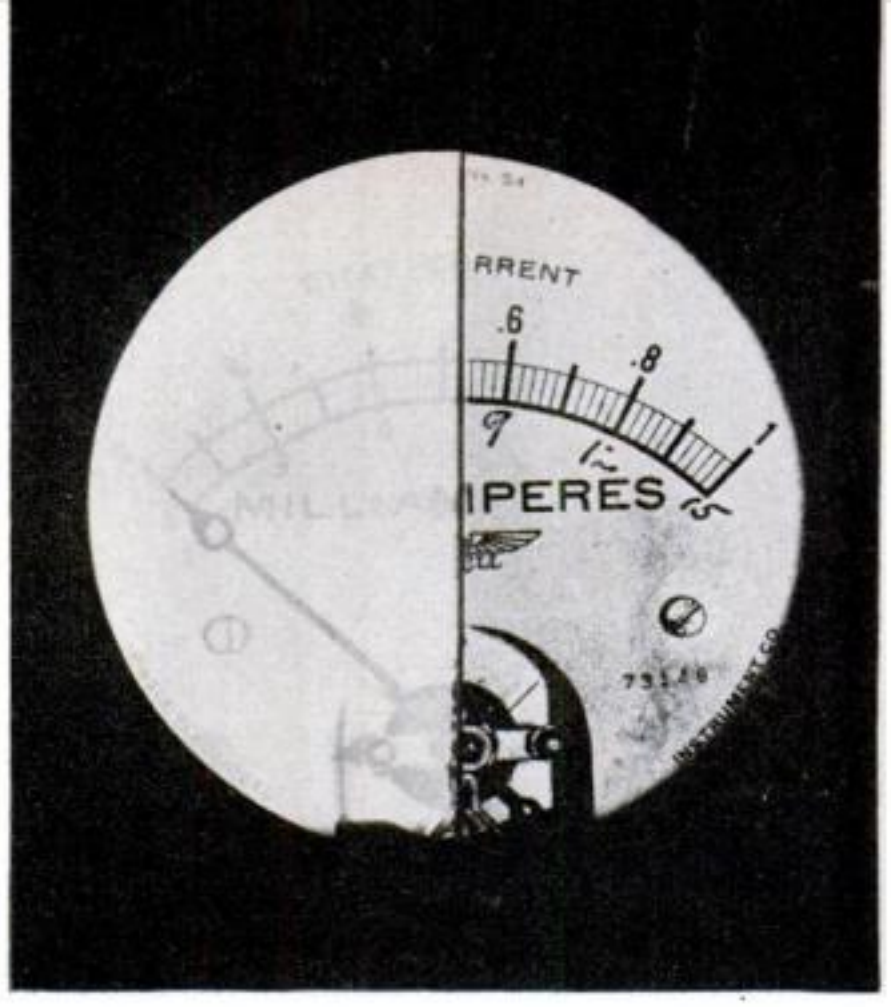
ROLLING HEADQUARTERS

DIRECTS ARMY IN THE FIELD

FOUR motor trailers, now serving as advance field headquarters for the U. S. Third Army, give a general no soft post far from the battle front. Instead, they may be whisked in a jiffy wherever tactical needs demand. In the woods, cut boughs camouflage them; among the shanties of a backwoods town, tarpaulins and paint transform them into innocent-looking dwellings or sheds. If a gas attack occurs, the cars may be sealed, while masked messengers deliver dispatches through a miniature air lock. Within, staff officers with war maps keep constantly in touch with battle progress through an elaborate telephone and radio system. To minimize danger from bombing, the trailers are parked 100 yards or more apart, and communication between the different headquarters units is maintained by telephone. To give an order, an officer may pick up a transmitter and dictate to a stenographer 200 yards away in the bushes.

At right, plugging in wire connections to the Signal Corps message center that serves the headquarters trailers. In a gas attack, messages are passed through air lock above

Half of the glass over the picture has had anti-glare treatment, leaving it free from obscuring reflections



Dial gauges under chemically treated glass are easy to read. Glare makes others hard

Hydrofluoric Acid Vapor Cuts Glare and Reflection in Glass

THE lives of many pilots may be saved by a new chemical process that is said to eliminate virtually all troublesome reflections on the glass used on airplane instruments, where an error in reading may mean the smashing of the ship. The process, developed by Dr. F. H. Nicoll, research scientist of the RCA Laboratories, is also reported to wipe out the glare and reflections and improve the clarity of glass used in show windows, camera screens and lenses, and picture frames.

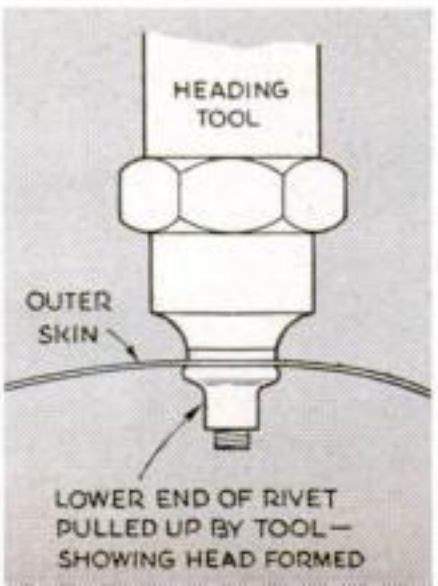
In the process, glass is exposed to hydrofluoric acid vapor. The vapor etches away a small amount of surface and leaves a thin, transparent film of calcium fluoride about one-quarter of a light-wave length in thickness. The film withstands rubbing, heat, and washing in water and alcohol.

Almost invisible, the film not only abolishes the reflection, but transmits the light otherwise lost in the reflection. It is purple, which would show, according to Dr. Nicoll, that yellow and green, colors to which the human eye is sensitive, are not reflected.

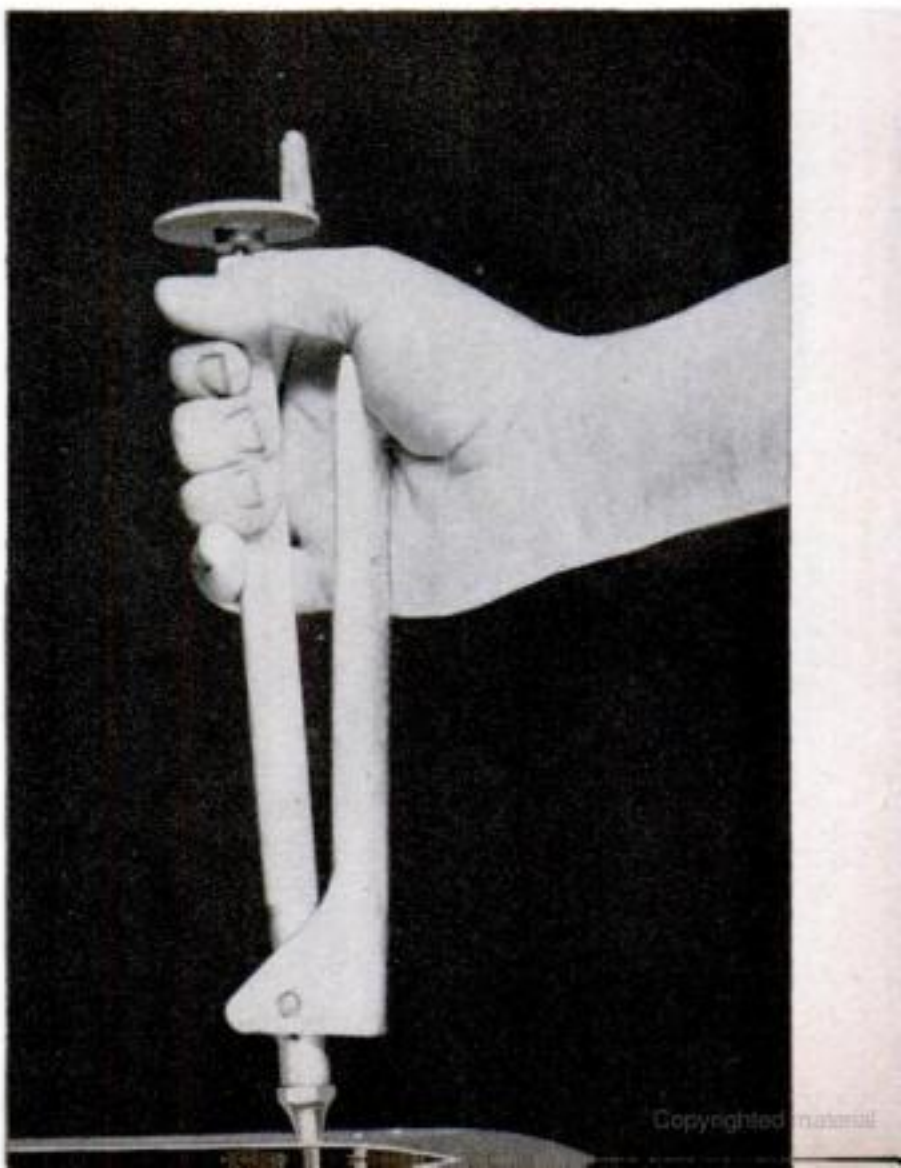
The discovery was made during experiments to improve the contrast of television cathode-ray tubes.

Threaded Tube Set as Rivet Speeds Fastening of Plane Fittings

ACROSS between a rivet and a nut is used to speed blind riveting of fittings on airplanes. It is a flanged tube with a threaded hole part or all the way through the stem, and is set into a hole by a heading tool which raises a bulge to prevent it from being withdrawn. The threaded hole left in the metal can be plugged with a headless bolt for strength.



Screwed on a threaded pinion of a heading tool, this new rivet-nut is inserted into a rivet hole. Operation of the tool handle draws the pinion back, pressing out a bulge in the rivet-nut which prevents it from being withdrawn. A threaded hole, which is left in the joint, can be plugged



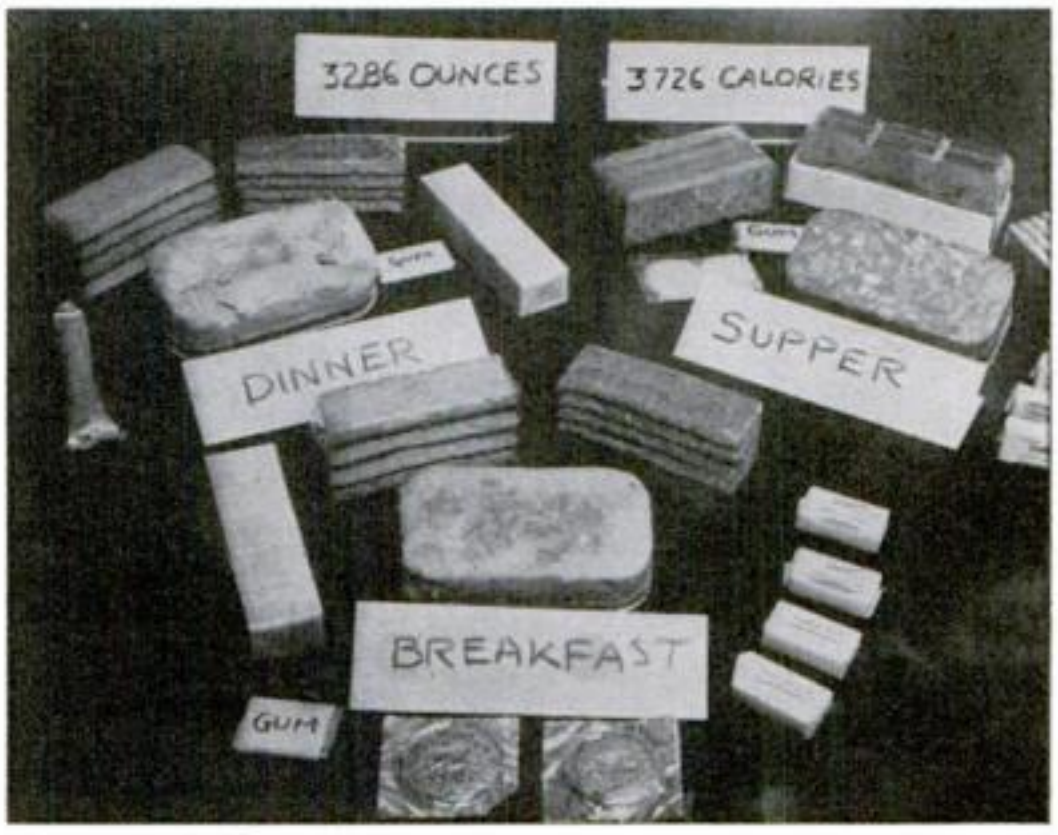
Quickly assembling his folding bicycle which dropped out of the air as he did, this U. S. parachute Marine gets ready for swift action

Paratroops Ride on Bicycles and Eat Compact Rations

THE sight of soldiers descending from the skies in parachutes is startling enough to most Americans, but they would be even more surprised to see these paratroops mount bicycles which floated down with them and ride away. The Marine Corps has been equipping its paratroops with bicycles that fold up.

Even the young paratrooper may be surprised when confronted by the new "para-rations" put up by the Quartermaster Corps of the Army. Nevertheless, the compact new battle rations (32.86 ounces by weight) contain 3,726 calories, or enough for three meals. Each pack contains pemmican and graham biscuits, malted milk tablets, soluble coffee, sugar, canned meats, and chewing gum.

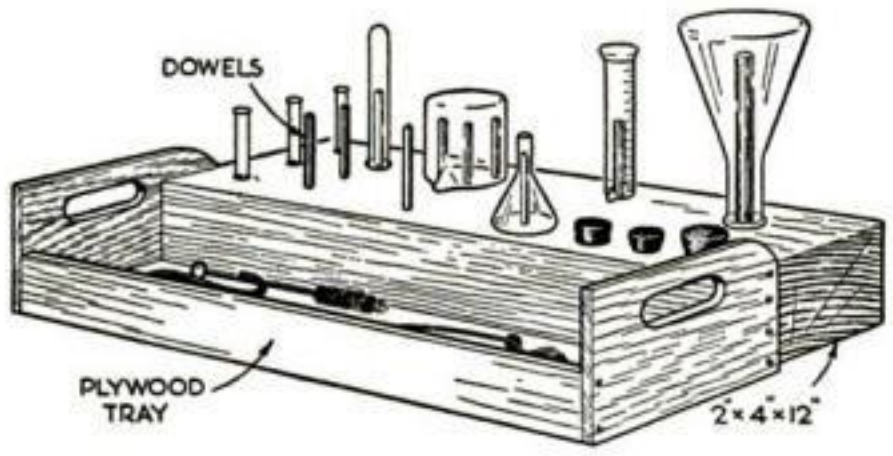
Not to be left behind, the Army has a new compact ration for its paratroops. Three meals weigh only 32.86 ounces

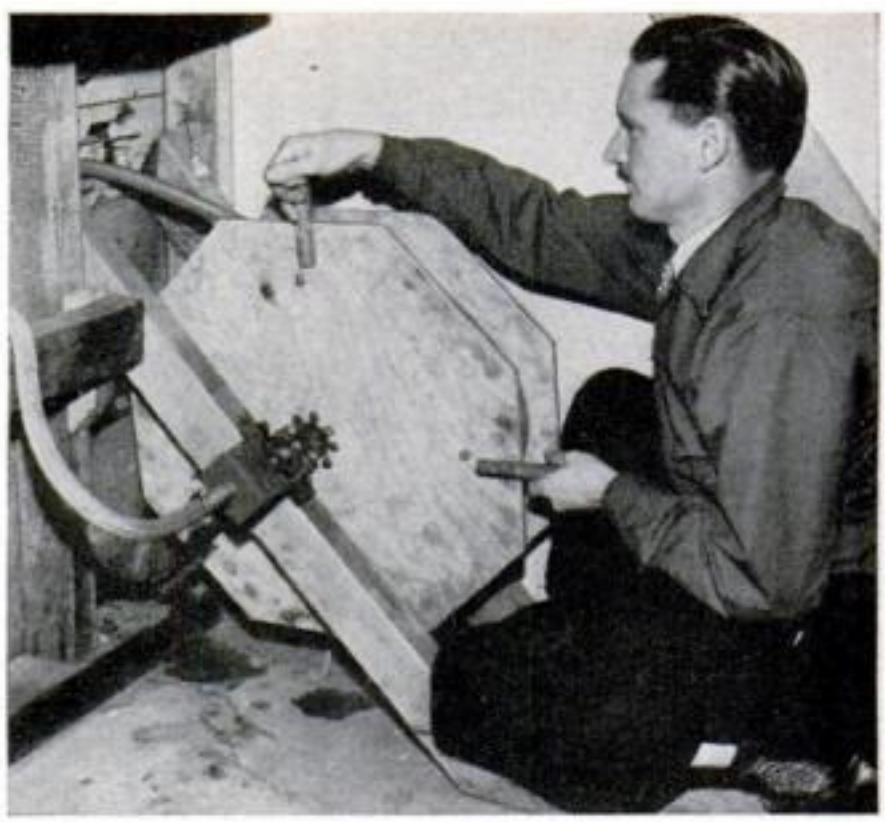


But in the small Army food pack are 3,726 calories, enough for breakfast, dinner, and supper for one man. There are pemmican, malted milk, meat, coffee, and even chewing gum

Neat Chemical Tray Is Made of Block, Plywood, and Dowels

A HOMEMADE chemical kit which a student can fit into his locker has been designed by W. Gilbert Spangler, head of the Science Department at the Berwyn, Pa., High School. The kit was made from a two-by-four block of wood 12 inches long with a plywood tray in front. Glass apparatus fits over dowels and test tubes are held in drilled holes. Rubber and glass tubing goes in the tray.

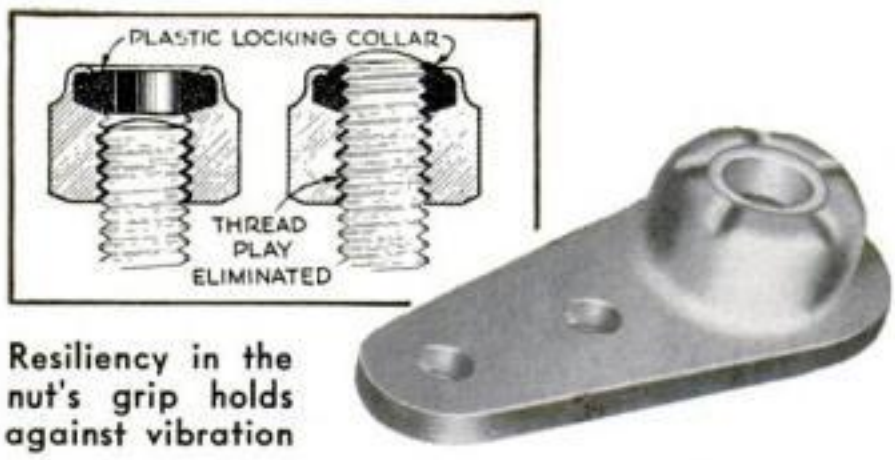




Heavy work of dragging out and storing the garden hose is eliminated with this self-winding reel inside the garage. The hose is pulled out through the bird house

Self-Reeling Garden Hose Appears through Bird-House Door

TO MAKE his garden hose a less prosaic tool, Luke Johnson of Los Angeles hides it on a self-winding reel inside his garage. When the hose is wanted for watering the lawn, the nozzle is drawn out from an innocent-looking bird house attached to the garage wall. A small wheel a foot or so from the bird house controls the water, which feeds from a pipe inside the garage. The hose is attached to the pipe with a watertight joint which turns with the wheel to prevent kinks. Rewinding is automatic. When the hose is let loose, a thirty-pound weight, suspended from pulleys and a sash cord, turns the reel and the hose snakes back into the bird house.



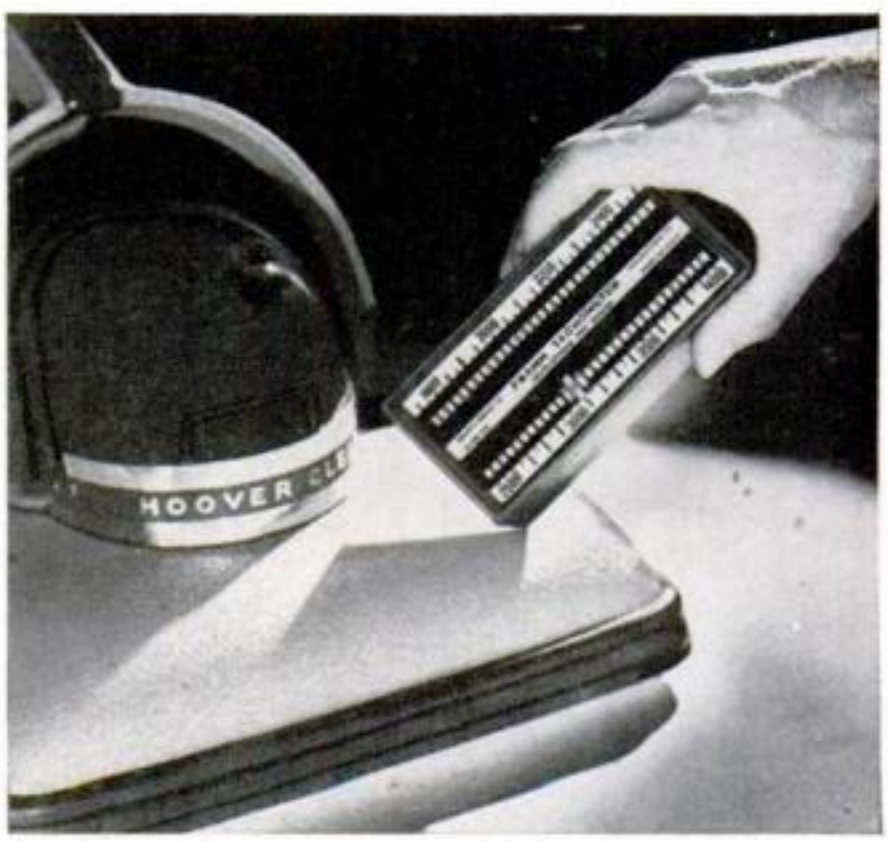
Resiliency in the nut's grip holds against vibration

Elastic Stop Nut Locks Itself

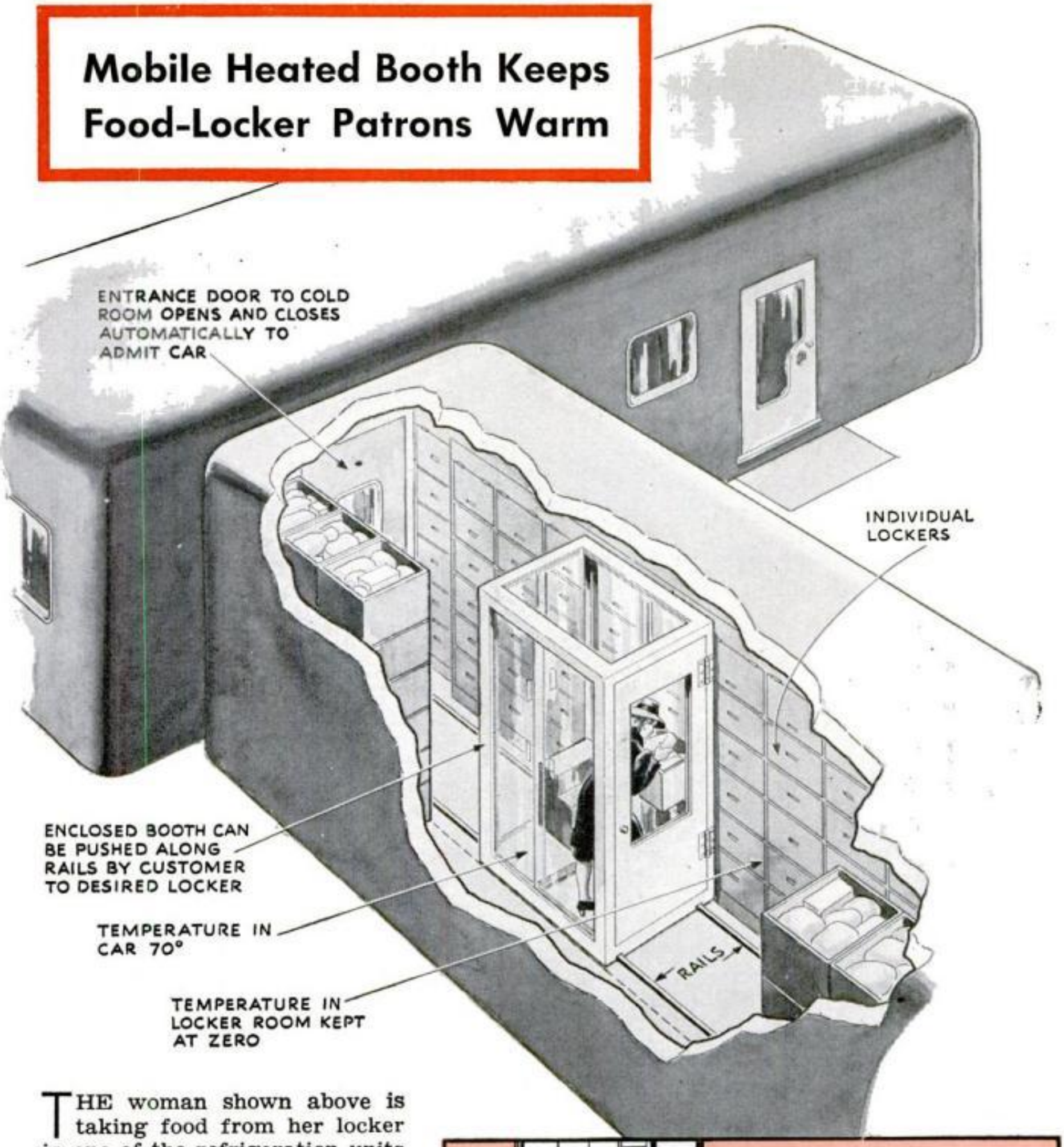
ELASTIC stop nuts, which lock themselves after they have been placed over a bolt, are being used on the new Army 37-mm. antiaircraft gun. They are said to be able to absorb vibration from rapid fire, because their elastic, nonmetal collar molds itself over the threads of any standard-size bolt and then locks.

New Device Measures Vibration and Speed Just by Touch

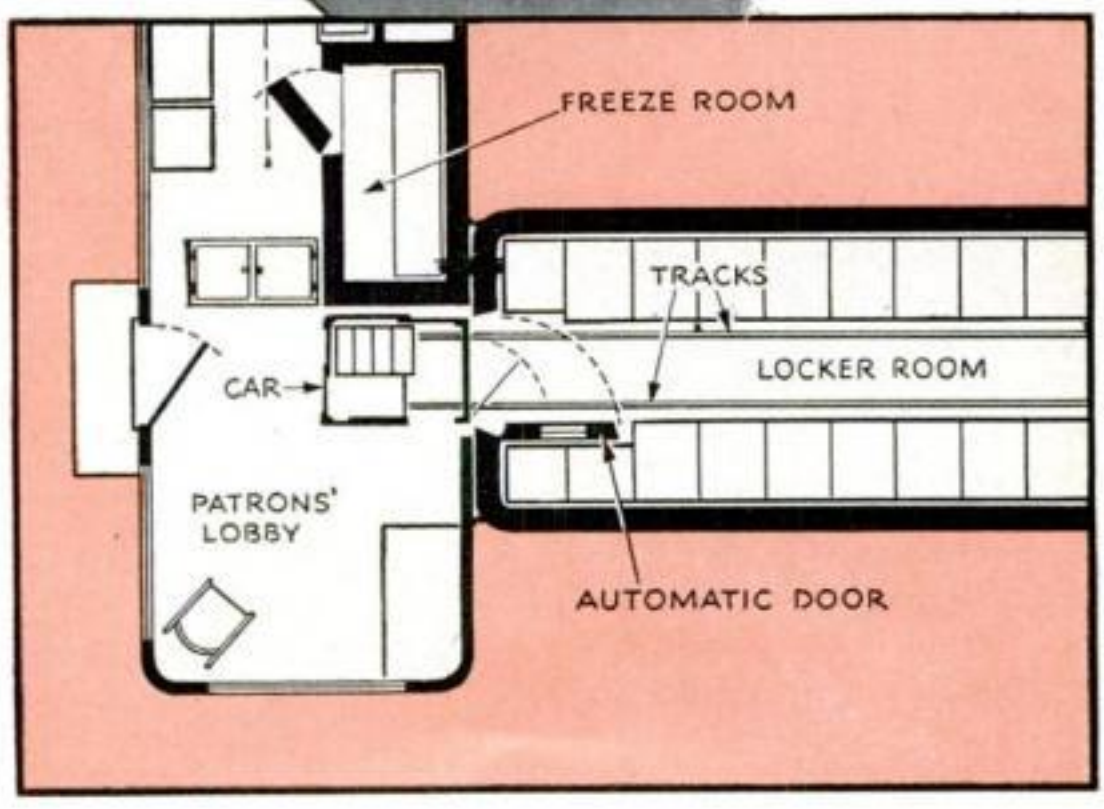
AN INSTRUMENT to measure by a mere touch the vibration and speed of many types of motors, ranging from airplanes to electric razors, operates with a mechanism of specially "tuned" reeds which vibrate in resonance with the motor—the rate of vibration equaling the speed of a machine. This device is said to be particularly useful in studying the relative amount of vibration in such things as airplane wings, pneumatic drills, saws, and vacuum cleaners. The instrument's dial is marked for either revolutions per minute or vibrations per minute, one being marked from 1,800 to 4,000 r.p.m.

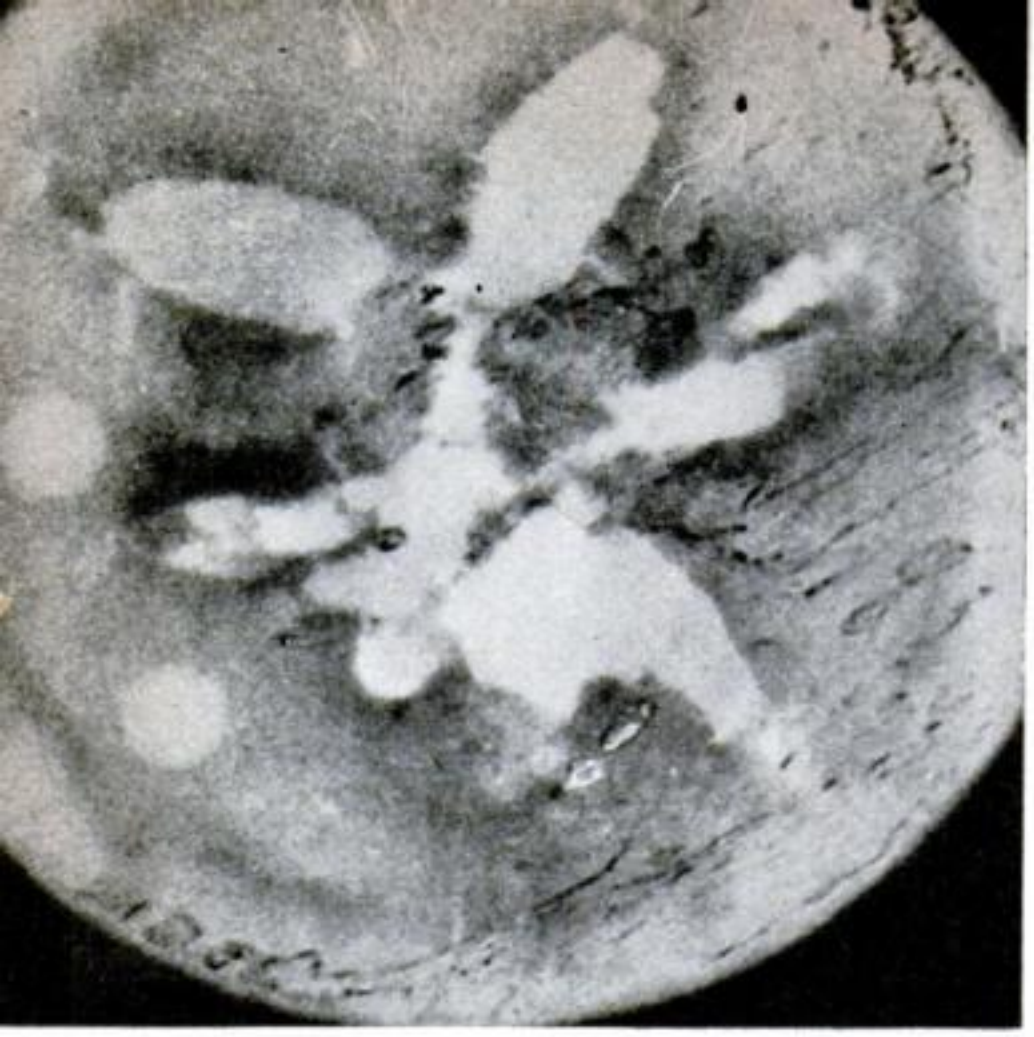


Mobile Heated Booth Keeps Food-Locker Patrons Warm



THE woman shown above is taking food from her locker in one of the refrigeration units of the Harmon Frozen Food Locker Company. The temperature in the locker room is at zero Fahrenheit. But the customer is not freezing, because the floorless booth in which she stands has a temperature of 70 degrees—normal for a room. Built of light transparent material, the "car" can be pushed by hand along a track from the patrons' lobby right into the locker room, through a door that swings closed automatically. A stepladder permits the customer to reach her locker if it is high above the floor.

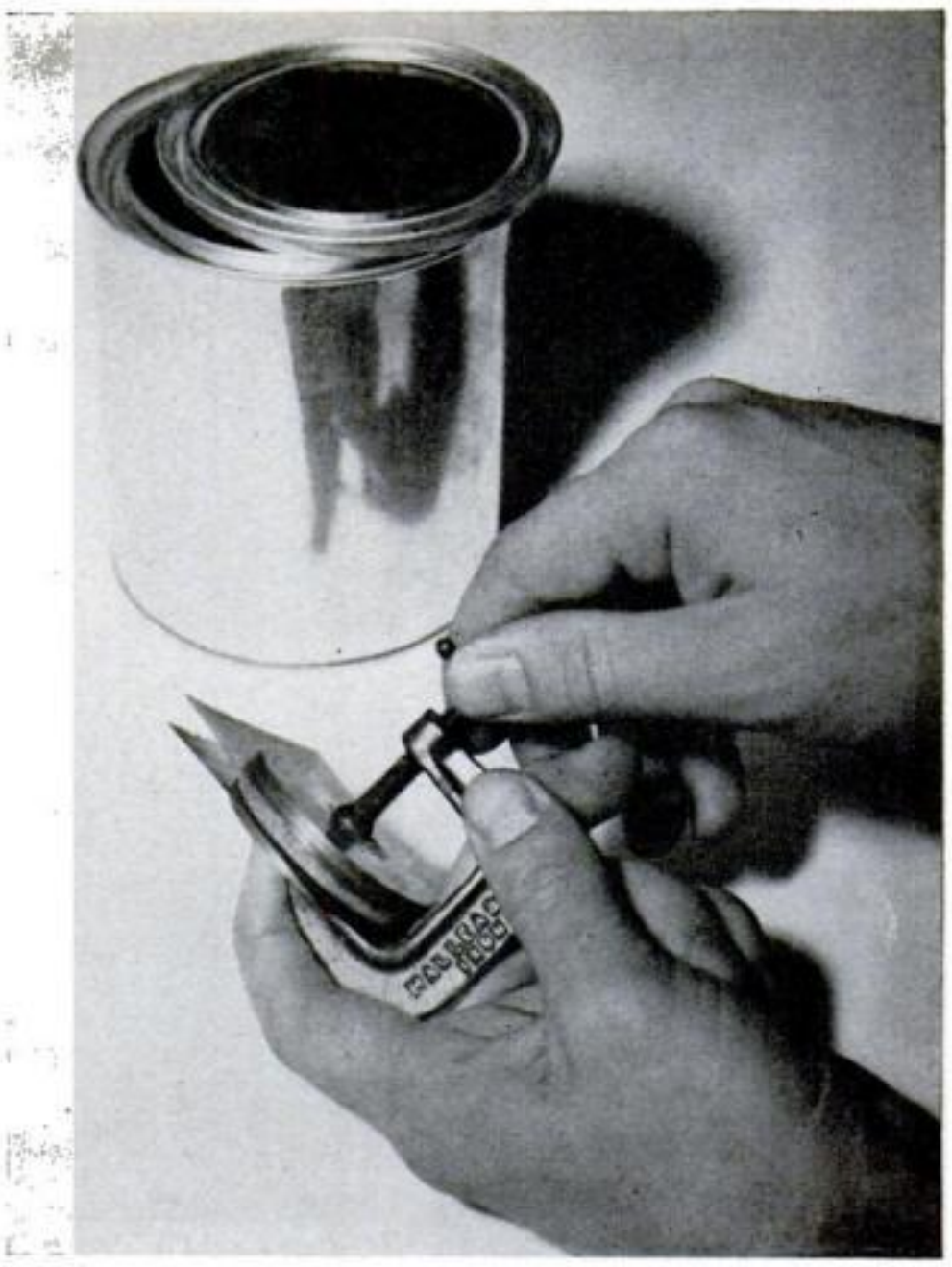




Inside of a steel disk, seen by "tin-can camera." Atoms of phosphorus are grouped around blowholes

Tin-Can "Camera" Locates Atoms Inside Steel Plate

ARTIFICIALLY radioactive substances, already of interest to medicine and biology, now aid the metallurgist. To a small batch of molten steel, Dr. William E. Shoupp, Westinghouse physicist, added phosphorus made ray-emitting, like radium, by exposure to an atom smasher. Then he clamped a piece of photographic film to each side of a disk of the steel, and left the assembly overnight in a tin-can "camera" that shut out light. Next morning, blotches on the developed photographs proved that phosphorus concentrates on the surface of small air pockets or "blowholes," a possible help in explaining why too much phosphorus makes steel brittle. Distribution of sulphur, carbon, manganese, and silicon may be studied the same way, and results may improve steel-making methods.



No lens, no shutter, no gadgets. Two sheets of film are clamped on steel, and all goes into a tin can

Milk Bottles and Glasses Get Germproof Rims

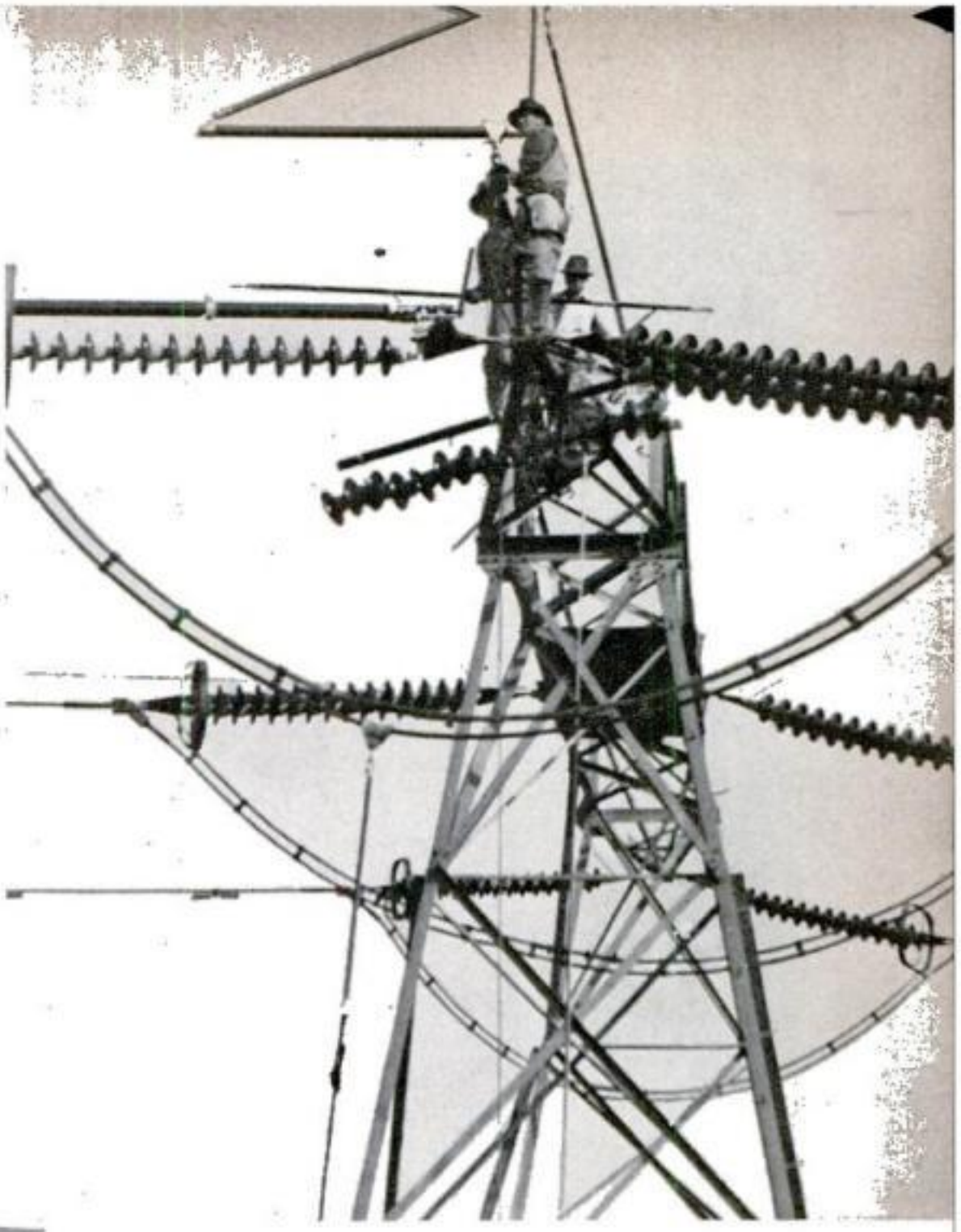
GERM-KILLING rims for glasses and for milk bottles have been perfected by Dr. Alexander Goetz, physicist, and Dr. Ralph L. Tracy, bacteriologist, of the California Institute of Technology. The coatings are expected to prove of great aid in curbing the spread of communicable disease, since they retain their bactericidal properties for at least two years and probably for the life of the vessel itself. Made of silver and a plastic, the material makes a decorative addition to the glass, and can be removed only by hard scraping with a sharp tool.

Dr. Tracy (left) need have no fear to drink this milk, poured by Dr. Goetz from a germproof bottle into a similarly protected glass

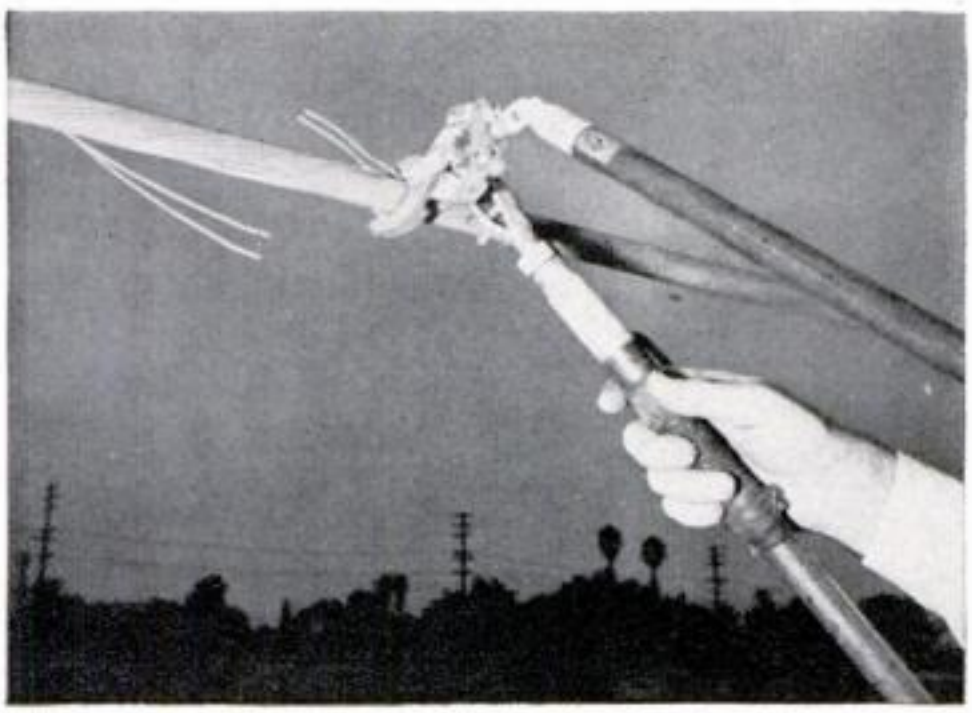
Handling the Hot Lines

MECHANICAL FINGERS developed by engineers of the Southern California Edison Company make possible day-by-day maintenance work on high-voltage transmission lines without disrupting service. Workmen replace dead-end insulators and suspension strings, test insulators, patch damaged conductors, and install vibration dampers while 220,000 volts surge through the lines at their finger tips.

Standing on the metal towers or atop extension ladders, workmen employ long sticks of treated Philippine mahogany and spruce to reach the energized parts.

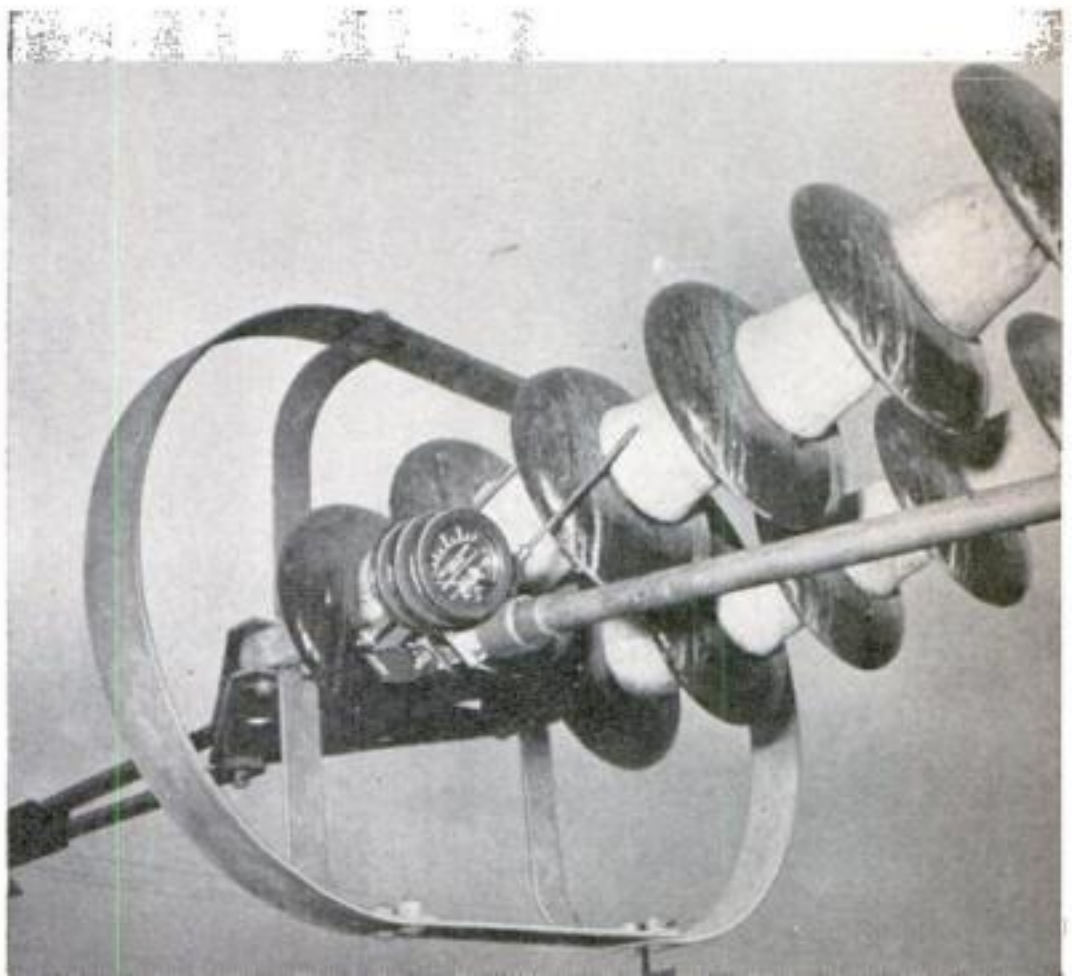


Perched atop a steel tower, hot-line maintenance men use an insulated "figure-4" rack to hold complete assemblies of 15 insulators in a horizontal position while they are being tested and repaired

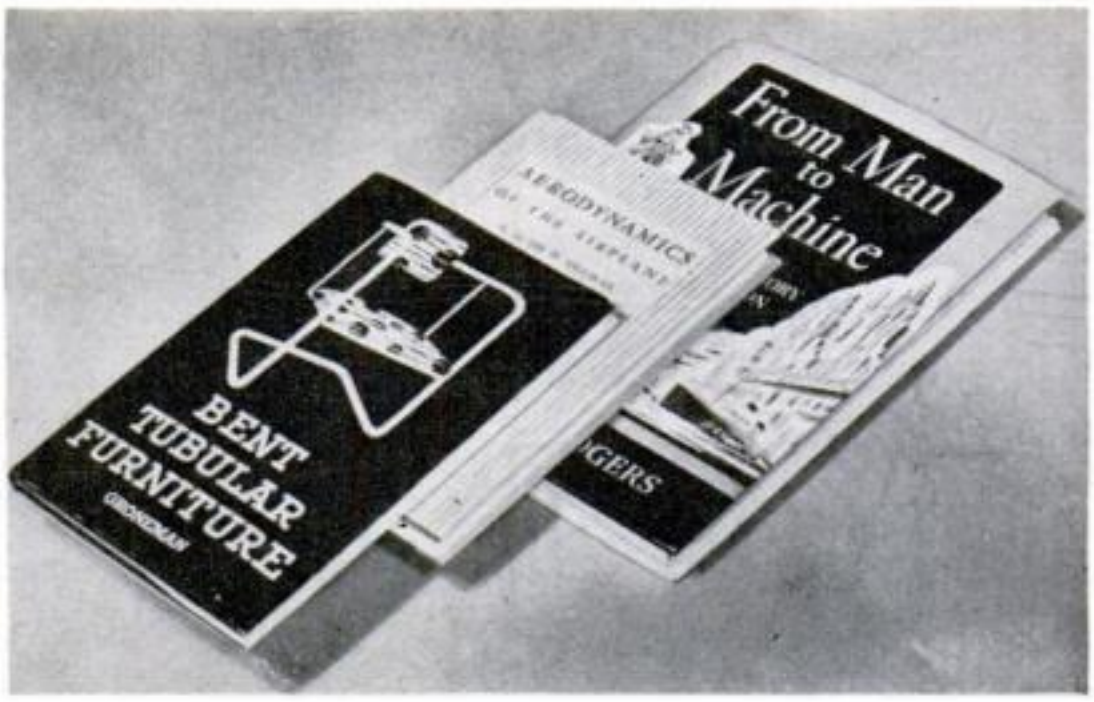


Below, an insulator tester mounted on a long pole detects faulty units. The meter gives a reading on each insulator as the two metal prongs come into contact with it. The long mahogany pole protects the workman from "juice" leaking into the insulators

Repairing a damaged conductor while 220,000 volts surge through it is the job of this tool, which forces loose strands back into the cable after cutting them off evenly as seen in photo below



Book Review



FOR THE CRAFTSMAN and the professional, "Bent Tubular Furniture" (Bruce Publishing Company) offers clear, concise diagrams and instructions for making 51 pieces of bent tubular furniture. All the articles of furniture listed in the book can be constructed in the home workshop with no extra equipment other than a bending jig. The author has provided a list of materials to be used with each new project with the accurate dimensions and the number of pieces needed.

"AERODYNAMICS OF THE AIRPLANE" (John Wiley and Sons, Inc.) offers a brief but intensive summary of aerodynamics for the aeronautical engineer, with special emphasis of fundamental fluid mechanical principles. Although the book is technical in content, methods of performance estimation and analysis have been treated in detail and two working charts are included so that the nonspecialist can make his own estimates or calculations in studying this branch of aerodynamics.

A BOOK FOR EVERYONE who is interested in machines and invention, "From Man to Machine" (Little, Brown & Company) contains copiously illustrated stories on most of the important mechanical inventions. The book starts with the origin of simple machines that were used by prehistoric man and follows up the development of these devices into present-day marvels in the fields of transportation, communication, arts, and crafts. "What Things Are Made Of" and "Women's Work" are other sections.

Question Bee

Minerals are important in our defense program. What do you know about them? Answers on page 222

1 Magnesium is valued because it *(a)* is highly magnetic *(b)* resists corrosion *(c)* melts at an extremely high temperature *(d)* is the lightest structural metal.

2 We can depend upon an abundant supply of nickel because about 90 percent of it comes from *(a)* Canada *(b)* Brazil *(c)* Cuba *(d)* Pennsylvania.

3 Mercury is sold by the *(a)* carboy *(b)* flask *(c)* cylinder *(d)* barrel.

4 Besides its use in jewelry, platinum is in demand for *(a)* incendiary bombs *(b)* airplane propellers *(c)* chemical catalysts *(d)* ball bearings.

5 Chromite is *(a)* a high explosive *(b)* a poison gas *(c)* a metal *(d)* an ore.

6 Experts consider manganese essential for making *(a)* bronze *(b)* steel *(c)* sulphuric acid *(d)* paper.

7 Wolframite is an important ore of *(a)* tungsten *(b)* zinc *(c)* vanadium *(d)* molybdenum.

8 There are considerable deposits of tin, not only in the far East, but also in *(a)* Minnesota *(b)* Libya *(c)* New Zealand *(d)* Bolivia.

9 Bauxite yields *(a)* zirconium *(b)* aluminum *(c)* cadmium *(d)* antimony.

10 The principal use of lead is in the manufacture of *(a)* pipe *(b)* ship anchors *(c)* storage batteries *(d)* five-cent pieces *(e)* toy soldiers.

AUTOS

How to Get Increased Mileage Out of Your Tires

(NEXT PAGE)

Crushed between the rim and a stone, as shown, cords embedded in the tire walls may break. Tire may go flat at once—or later when least expected!

Tire Tips FROM A TEST-CAR DRIVER

By WALTER E. BURTON

WHAT would you do if some one handed you a set of brand-new tires and the curt order: "Wear 'em out in three days"?

There are men who have received such assignments without blinking, and have carried them out to the letter by reducing a set of new tires to scrap in 72 hours of driving—in a mere 2,500 miles on the road. While such a task is among the rarer chores given to drivers of the tire-company test cars, it illustrates how quickly an automobile tire can be consumed.

By knowing how a test-car driver wears out tires at ten times the normal rate, you can avoid some of the life-shortening abuses you may be unwittingly heaping upon your tires. Here is how Willard Russell, veteran Goodyear test-car pilot and tire-test supervisor, would carry out the assignment:

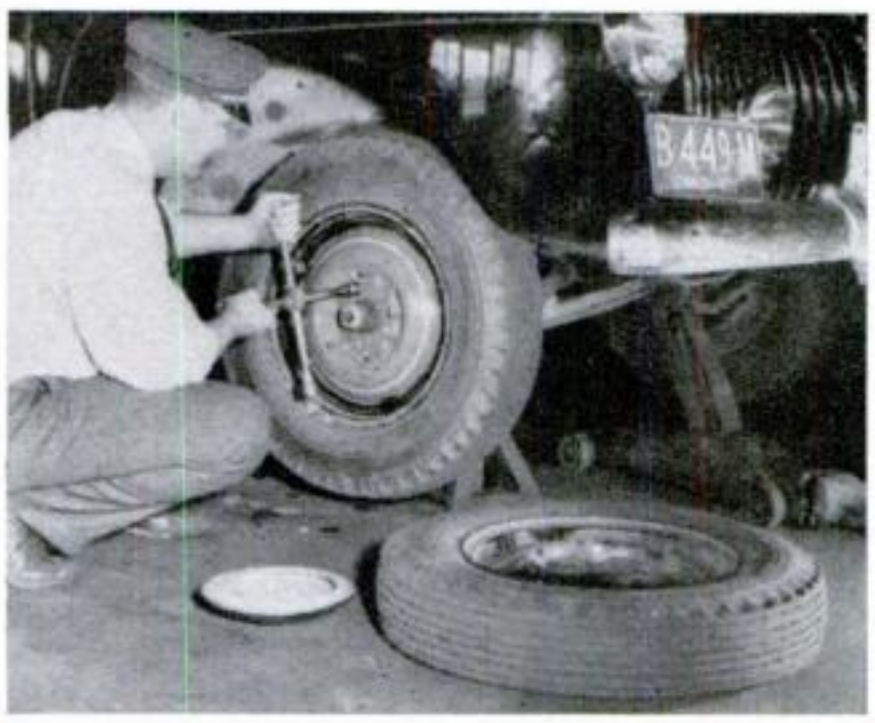
Underinflate each tire about 20 per cent. Drive in hilly country where the roads are twisty and the grades steep. Select a pavement having a "sandpaper" top. Choose hot, dry weather. Take curves so fast that the tires slide and squeal loudly, and run mostly on the road shoulders. Spin the wheels when starting, open 'er up to 70 or better when you can, and always make screaming, split-second stops.

Of all common pavement surfaces, gravel roads like this are hardest on car tires

That is not preferred practice in these days of defense shortages. But occasionally such test-car operation is necessary to find out exactly how a tire will behave. Ordinarily, the tests duplicate as closely as possible average use.

The Goodyear Tire & Rubber Company's test fleet of passenger cars, trucks, scout cars, and

Tire test-car drivers halt their grueling runs three times in every eight hours to measure and record air pressure on charts and note pressure changes



Shifting tires periodically, according to a fixed plan, is one of the best ways of offsetting a number of tire-wear conditions of normal driving

And new or changed tires should always be balanced on a machine that spins the wheel assembly to show where to add rim weights

other types of vehicles has covered nearly 32,000,000 miles, or farther than the average motorist would drive in 3,200 years. The ace of the fleet is G. P. Mathieu who, driving an average of 36 miles per hour 40 hours a week for 36 years, has run up a total of 2,500,000 miles. It would take you 250 years to drive that far, if you are an average "high-mileage" motorist. Among the 54 other Goodyear test drivers are J. H. Greenleaf, a 2,100,000-miler, and four who have passed the 800,000-mile mark. The main Goodyear fleet now operates the year through from its headquarters in Litchfield Park, Arizona.

Here widely varied temperature and atmospheric conditions are available for tire-aging tests. In these, many sample tires may be exposed simultaneously for long periods on outdoor platforms (see AUTOS cover) to determine their resistance to the elements.

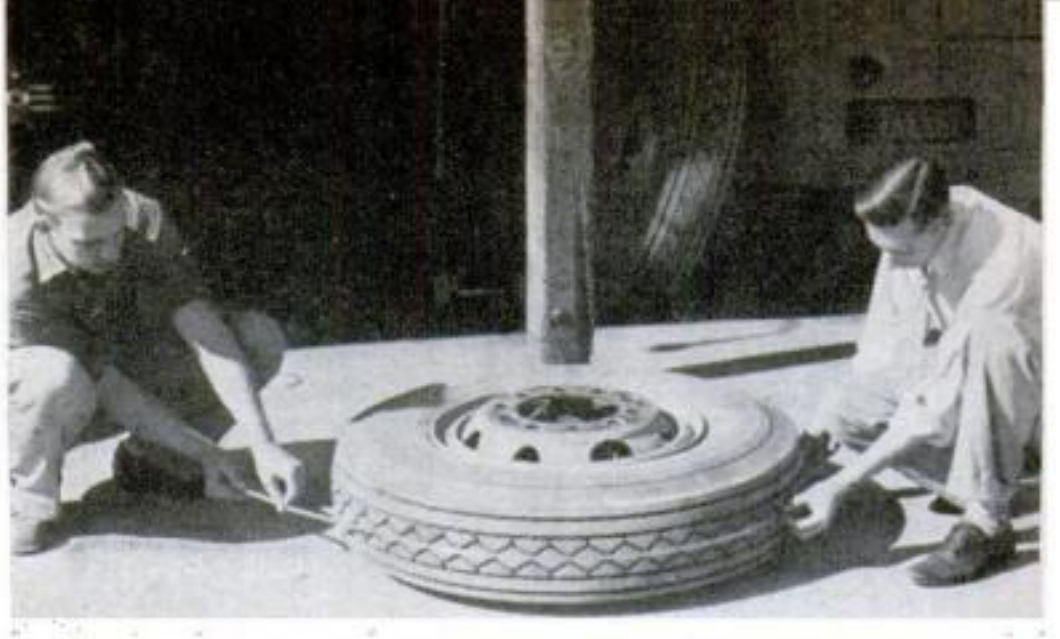
Important work must be done before a test car starts out and after it returns. Each tire must be inflated to the precise pressure required by the test. The wheel assembly is balanced statically and dynamically on a standard balancing machine, unless the test calls for unbalance. With special micrometers, tread thickness is measured to 0.001".

On an ordinary mileage run the test car travels at a specified speed of 50 or 60 miles per hour. About three times during each shift the driver checks the tire pressure, looks for tire cuts and signs of other damage, checks the head and tail lights if it is night, washes bugs and dirt from the windshield, and otherwise gives the car a quick going-over. Incidentally, that would be an excellent practice for any motorist on a trip.

The test driver does not pick up hitchhikers, nor investigate every petty happening that may invite attention. Now and then he will help a stranded motorist, particularly in thinly-populated country, even though such stops mean loss of time and tire mileage. There is a rule that test drivers must get the normal amount of sleep before going on their shifts, so they won't become drowsy at the wheel. When they do feel sleepy while driving, they stop, get out, and walk around the car a few times until they feel wide awake again.

The test-car drivers have a safety record that stands out like a lavender church. Seldom is there an accident involving a test car, and almost none that are not traceable to the actions of some careless motorist. When asked to suggest a reason for this, one veteran tire-testing specialist replied promptly: "Anticipation. Our drivers are all past masters at anticipating what they

Tire tester paints tell tale marks on truck tire where critical measurements of changes in diameter and tread thickness will be made after a run



Here the same tire gets an exact circumference measurement before being put through a severe test. Later measurements will show the rubber lost

A special micrometer gauge measures tread thickness in thousandths of an inch before and after tests. Below, entering readings on a chart

Inspecting a tire after a run over an all-year Arizona test course. Sharp stones and other objects are removed here to prevent later punctures

are going to do and what the other driver is likely to do. When they intend to make a stop in routine driving, they don't make up their minds at the last second, and then jump on the brake."

Another thing that has contributed to test-car safety, according to test-supervisor Russell, is driver smoothness. Russell himself is an example. A ride of only a city block with him is evidence that here is an experienced driver who knows how to handle a car. No tire-spinning starts or sudden stops for traffic lights.

Test-car men have learned from long experience a lot of tricks that, if used by all motorists, would conserve an amazing amount of rubber, gasoline, and oil, to say nothing of prolonging automobile and human life. Here are some of the things test-car research has proved about tires and their proper care:

WHAT YOU CAN DO FOR DEFENSE

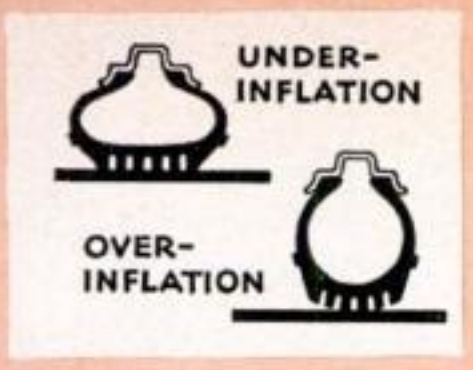
Inflation: Underinflation increases tread wear, causes walls and cords to break down, and increases susceptibility to pinch damage. Overinflation concentrates wear in tread center, makes wheels bounce, spin, and skid, and promotes bruises and hard riding. Running flat may ruin a tire in a few seconds.

Pinching, bruising, overloading: Often coupled with improper inflation. Pinching usually is caused by striking objects which fold a tire wall against the rim, often breaking or loosening cords. Bruising comes from striking stones, chuck holes, or curb. Overloading magnifies effect of such abuses.

Wheel alignment: Misalignment scrubs rubber from tread. Similar damage comes from improper front-wheel camber and

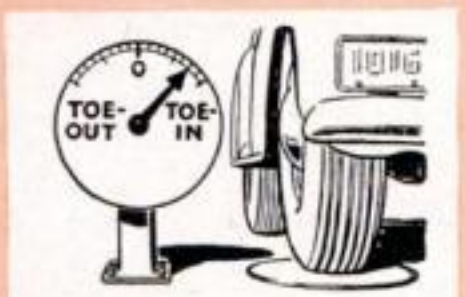
WHAT YOUR TIRES LOOK LIKE INSIDE

As shown below, automobile tires are really layers of cotton cord and rubber, most of them anchored at the beads by loops of fine steel piano wire. Amazingly tough, they are not indestructible. For tips on getting the most out of them, see the accompanying sketches

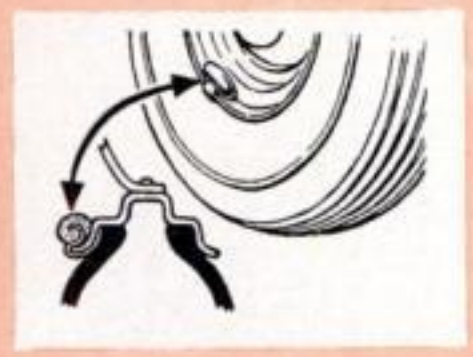


Too little or too much air speeds up tire wear

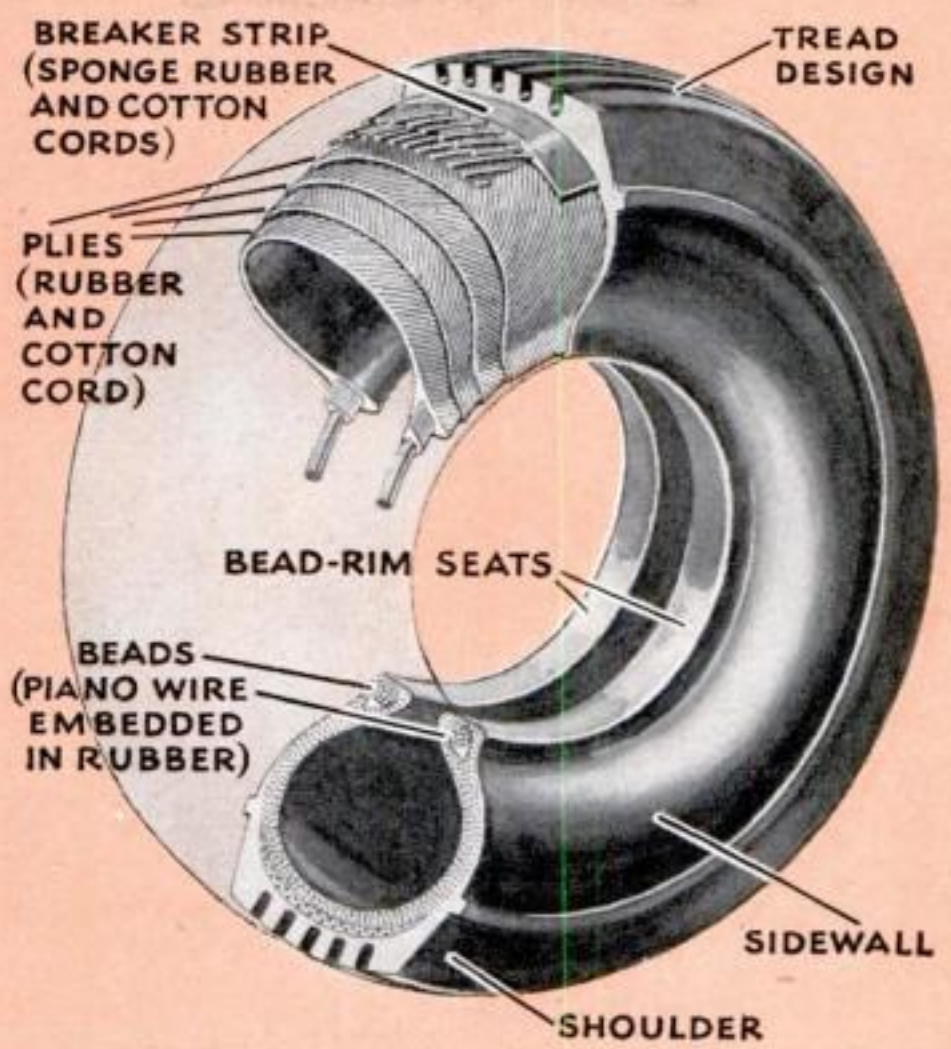
Carcass crushed against rim may break ply cords

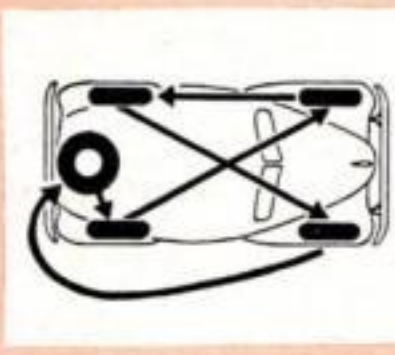


Out-of-line wheels scrub away good tread rubber



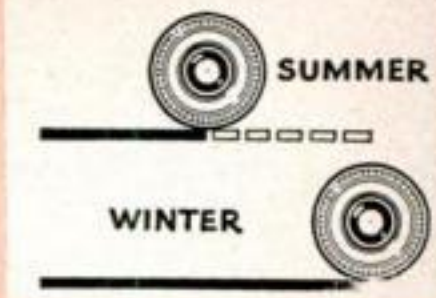
Unbalance wears tires unevenly. Cure: rim weights





Shift tires periodically to distribute the wear

Descend a hill in same gear you'd use ascending



Speeding may halve tire life during hot weather

Jack-rabbit starts grind rubber from rear tires

Fast driving speeds up all normal tire damage

Conserve rubber by retreading good carcasses

caster, bent axles, loose bearings, wheel wobble, unequal brakes, and out-of-round drums.

Wheel balance: Always balance wheels statically and dynamically when tires are replaced or changed, by adding rim weights where indicated by a testing machine.

Shifting tires: When ribbed treads are on front and high-traction treads on rear, front tires are interchanged and rear ones rotated to include the spare. When treads are all alike, front tires are moved straight back to rear wheels and rear ones diagonally forward. To include spare, see diagram.

Weather and temperature: Tires may wear 50 per cent longer in winter, since snow, ice, and rain reduce friction, and rubber is tougher when cold. Avoid sharp objects when rubber is wet and easily cut. Avoid speeding in hot weather.

Brakes: Keep brakes equalized and apply them gently. Use second gear descending steep hills; or the same you would ascend in.

Starting: Wheel-spinning starts grind off tread, especially in gravel and cinders.

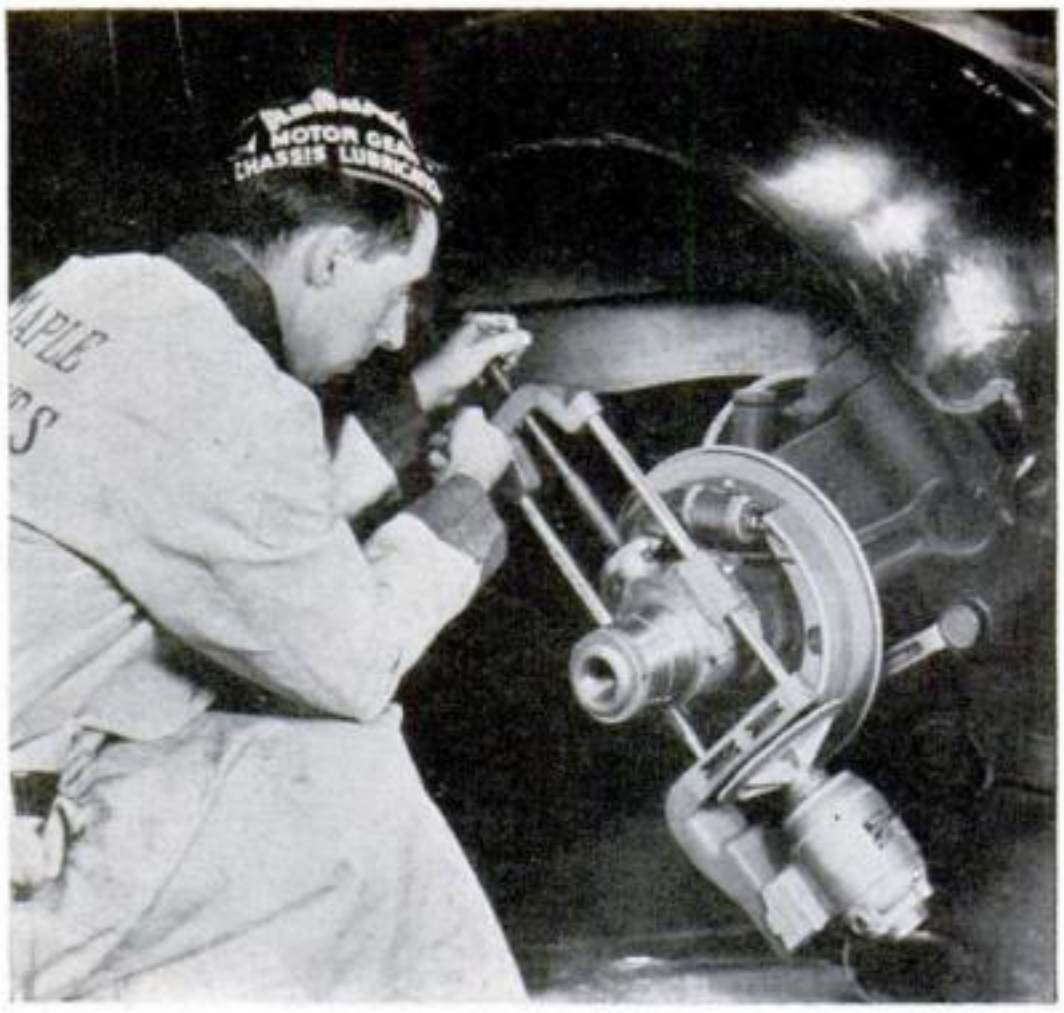
Speed: High speeds wear treads faster, increase necessity for braking sharply, and cause tires to hit obstructions harder.

Blowouts: Avoid use of blowout patches when possible. Such patches can ruin tire and tube quickly.

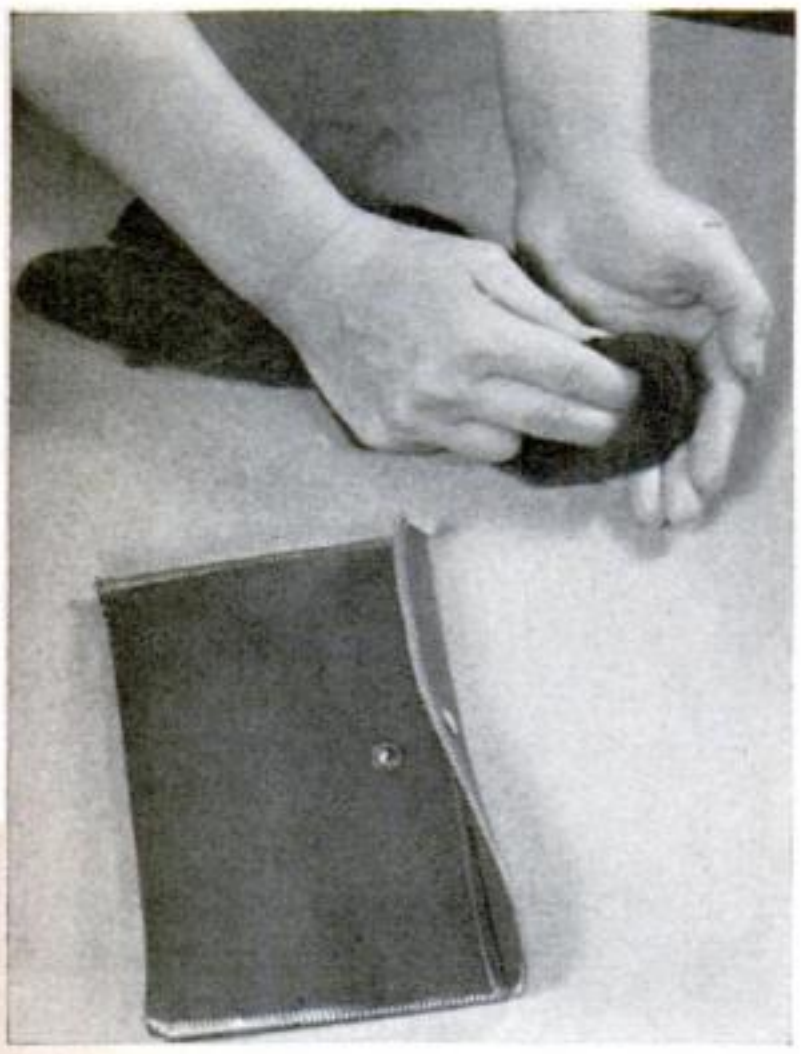
Retreading: Recommended for sound carcasses for rubber economy, as is earlier regrooving of treads worn smooth on similar carcasses. Intrust this work to competent establishments.

Perhaps the most important single fact proved by the million-mile drivers of the various large test fleets is this: The kind of driving that is safest for the driver, his passengers, pedestrians, and the occupants of other cars is precisely the kind that produces longest life in tires and the car itself.

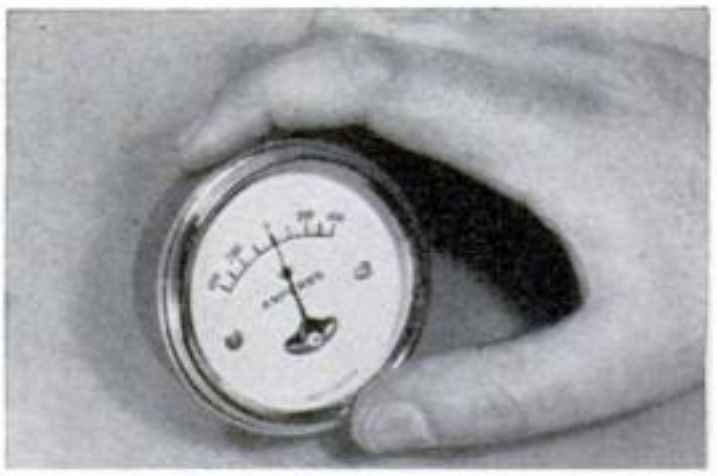
Auto Ideas



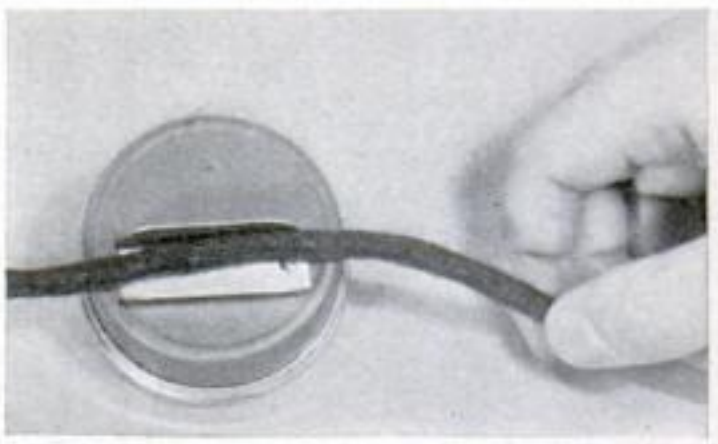
BRAKE-LINING FACES are ground to a uniformly flat surface without removing them from the car, by means of the electric grinder illustrated at the right. The fact that the grinding is done with the brake shoes in place is said to make possible an accurate adjustment of the brakes when the drums are replaced. Clamped to the axle, the tool is swung by hand as an adjustable, motor-driven sanding disk rotates continuously against the surface of the brake lining to produce the desired finish on the surface.



GREASE STAINS are quickly removed from the hands with a chemically treated rubbing cloth that requires no soap or water. The cloth is made of toweling material and has its own waterproof packet in which it may be carried. Besides grease, it removes many other common stains.



A COMPACT METER instantly measures the current used by an automobile or truck starting motor. Pressed as shown in the lower picture against a section of the cable between the starter and switch, the new meter indicates the current consumption as soon as the starter switch has been closed.



TREATED PAPER TOWELS, a glass-cleaning compound to be used with them, and a whiskbroom, are all contained in a handy new receptacle that can be attached to service-station gas pumps for courtesy cleaning of car windshields, windows, and floors. The towels are said to remove the most stubborn "traffic film."

POPULAR SCIENCE

Three U. S. highways and a state highway merge to approach George Washington Bridge, in New Jersey. The shield, with the state name at top, is official U. S. highway symbol. The circle, state symbol

What Do You Know About *Highway Signs?*

By SCHUYLER VAN DUYNE

DO YOU KNOW what the seven signs above mean? They're all road signs, and as the driver of an automobile, a truck, a bus, or a motorcycle, you should be able to recognize them instantly by their shapes alone. They comprise the highway shorthand of the road, a simple symbol language that can be learned in a few minutes. Yet only one out of a thousand motorists is able to identify, by shape, more than three of the seven.

Take time out and give yourself a test. Try them on your friends. Then compare the answers with the official symbol dictionaries—the "Manual on Uniform Traffic Control Devices for Streets and Highways," and the "Uniform Act Regulating Traffic on Highways."

Here are the correct answers, reading from the left: The Square, caution; the Diamond (really a square tilted on one point), slow; the Circle, railroad tracks ahead; the Arrow (white on black), detour or one-way; the Octagon, stop; the Clover Leaf, rest station; the Cross-Buck, railroad crossing.

Know this green cloverleaf. It is easily recognized

This simplified system of highway shorthand grew out of the combined and tireless efforts of a great many traffic experts — statisticians, engineers, scientists, and highway officials—and in the seven simple signs they have devised a language without words that makes it possible to read the rules of the road merely by the automatic visual impression of a sign's shape alone. To make it still easier they added two more simple things—color, and symbols within symbols.

Thus you will note that the square, circle, diamond, and oc-

tagon always are yellow with black lettering; the arrow and cross-buck, white; the clover leaf, dark green. The yellow squares or diamonds become more comprehensible by the signs within them; for example, a snake-like line to indicate an S-curve, or a T lying on its side to warn of a side road. They carry printed messages too, "hospital," or "men working," or similar cautions, but these to a motorist who has memorized the shorthand are of secondary consideration. A long time before he is able to read what a sign says he knows by observing the square or the diamond that he is to be on the alert, just as he knows, by noticing a cross-buck, that it is time to look out for a train.

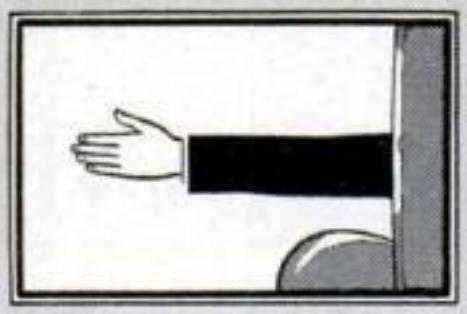
To make them easier to learn, the highway symbols have been divided into three classes; regulatory, warning, and guide signs. The octagon is in the first classification; the square, diamond, circle, and cross-buck are in the second, and the arrow and clover leaf are in the third. It is obvious that if everyone learned to read this symbol language, instead of regarding it as so much Chinese, the number of lives and injuries and the amount of damage from highway accidents would be reduced drastically.

There is another system of highway shorthand which is becoming more and more standardized each year. This is the language of stripes, those vari-colored lines which streak along cement or macadam sometimes for miles at a stretch. More motorists appear to know the meaning of these lines than of the side-of-the-road symbols but there are still maniacs at large who regard them merely as a form of decoration.

HAND SIGNALS FOR DRIVERS

LEFT TURN

No tricky hand wiggling; just the arm and hand extended out from the left side of the car, by the driver —and only the driver



RIGHT TURN

Extend the straight arm upward at an angle. Signals should be given 100 feet or more in advance, depending on your speed

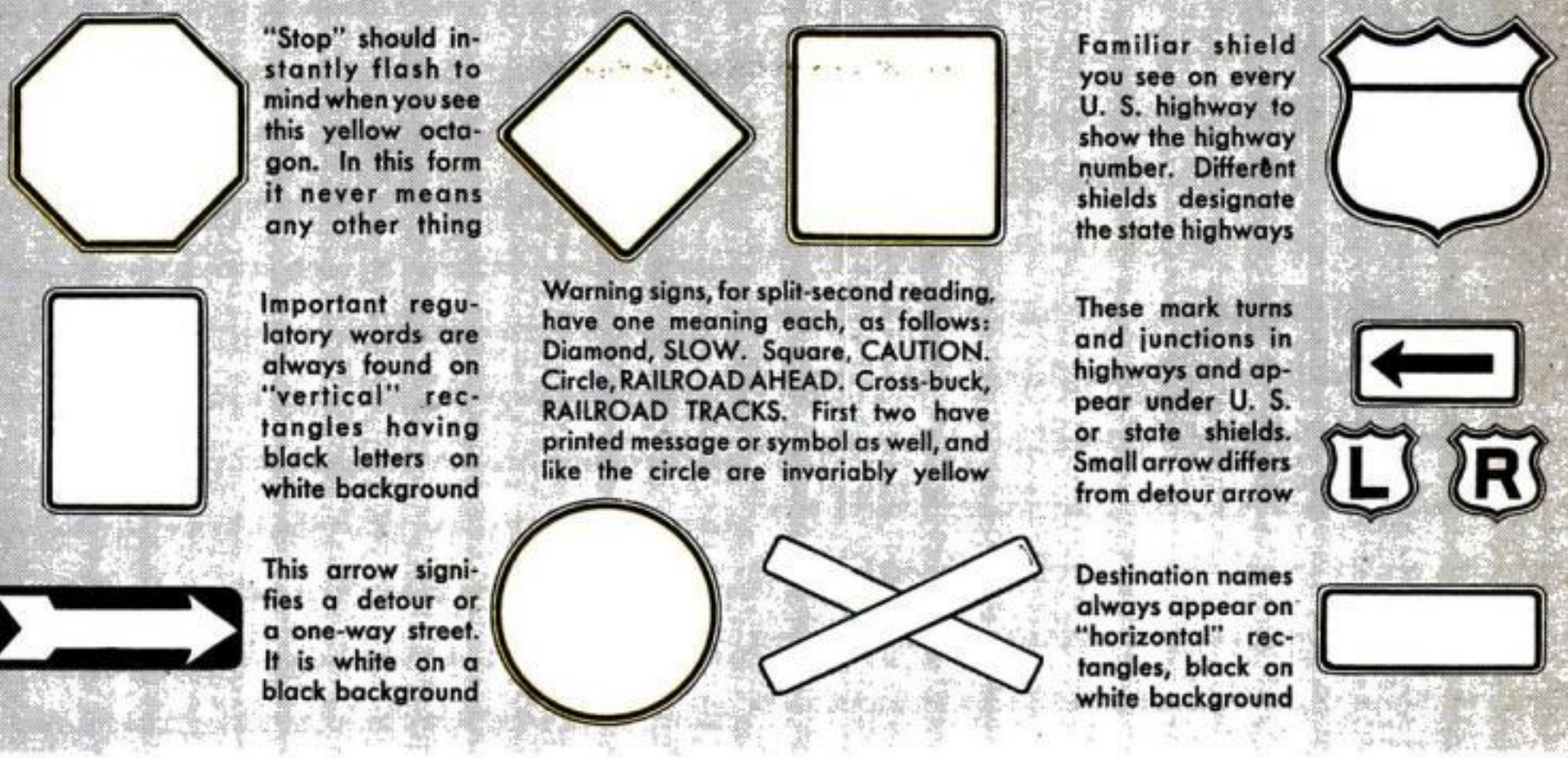
STOP OR SLOW

Also made by straight arm, extended downward. Be sure these are your state's official signals. If not, learn what they are

The rules are simple. Rule No. 1 is that a single line should not be crossed without caution—look ahead and behind to make sure traffic conditions warrant it. Rule No. 2 is never cross a double line. Rule No. 3 is never cross a special-hazard line except under specified instruction. In this connection various experiments are being tried by several states; such as broken lines, lines of contrasting colors, or a combination of broken and solid lines. Rule No. 4 is always drive in the lane farthest to the right unless

TYPICAL STANDARDIZED HIGHWAY SIGNS OF THE SPREADING

EVERY DRIVER SHOULD KNOW THESE UNIFORM SIGN SHAPES



otherwise indicated. Rule No. 5 is never overtake and pass another vehicle occupying the lane to your left.

Although the "Uniform Manual" lists the places for use of the various lines, prescribes their dimensions and paint materials, there still exists considerable lack of uniformity among states in pavement striping. But an inquiry at the nearest Motor Vehicle Bureau will straighten out things in your vicinity.

How many times have you been driving along and seen the motorist ahead extend an arm from the window, letting it droop meaninglessly! You edge a bit to the left, thinking he or she is about to slow down or stop. Suddenly the car crosses you with a left turn. You put on the brakes, you yank the wheel to the right and, if fortune favors you, you drive on with a gritting of teeth.

Yet this may not be altogether the fault of the motorist ahead. Nowhere in driving rules has there been less uniformity than in the trio of hand signals, and improvement is slow. Your own state may still have its preferred and nonconforming rules. You should find out if this is so. Otherwise, where the "Uniform Vehicle Code" system has been adopted, and conflicting laws do not exist, these are the standard hand signals:

Left turn: Hand and arm extended horizontally.

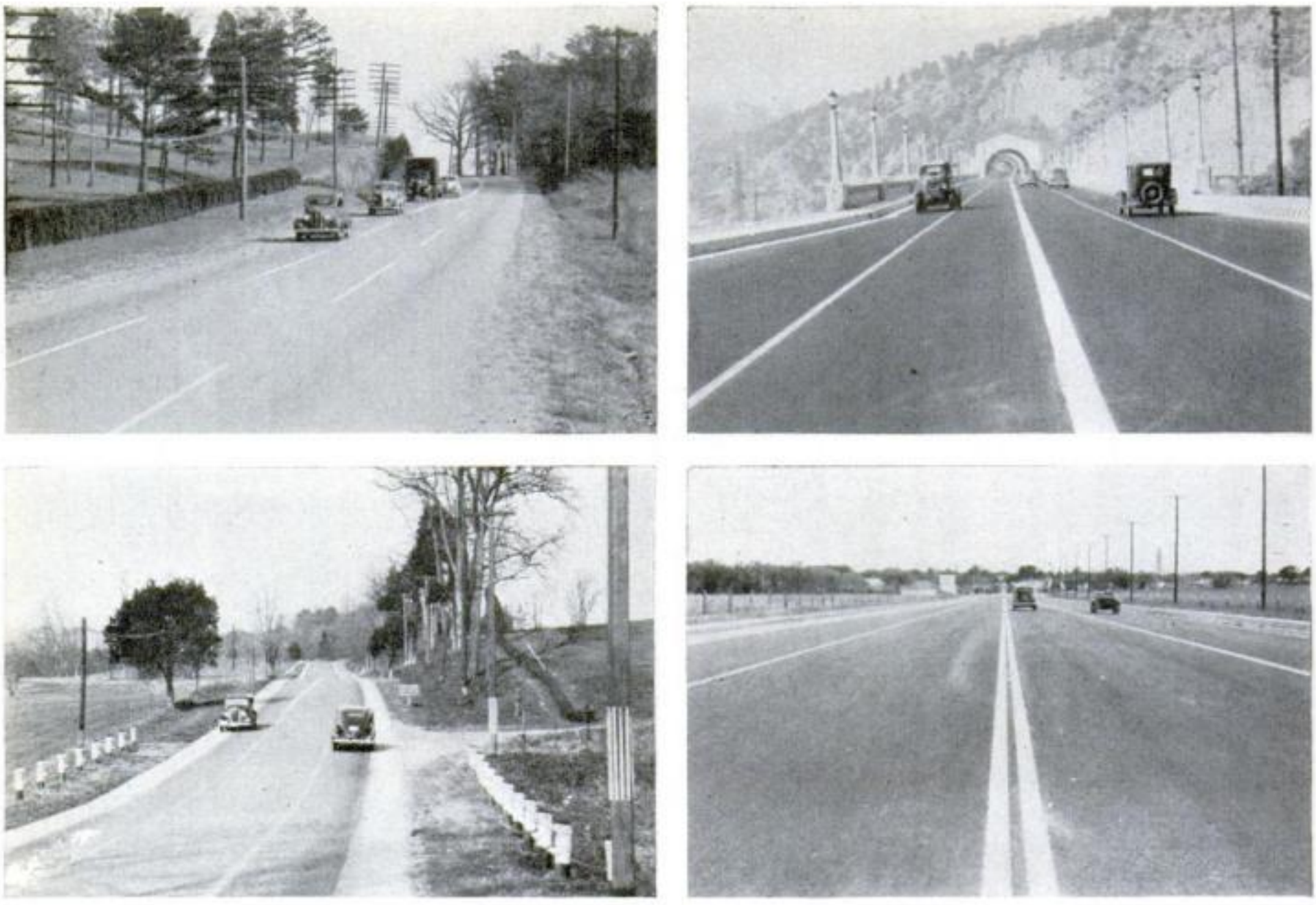
Right turn: Hand and arm extended upward.

Stop, or decreased speed: Hand and arm extended downward.

The driver alone should give these signals. It does not add to the peace of mind of the motorists behind if a driver's friends or family attempt to assist him in the operation. The resulting maze of signals is likely to indicate that he is going to make a right turn, a left turn, and a stop for a frankfurter at the roadside stand ahead.

The Federal Government long since has taken the lead in the standardization and simplification of highway signs, and this is particularly important today with the additional flow along the highway arteries of hundreds of thousands of military and defense-industry vehicles, ranging from speedy

NATIONAL UNIFORM SYSTEM



An important function of highway stripes is to indicate a reduction in the number of traffic lanes, as when approaching a curve or a hill where it is dangerous to overtake and pass other vehicles. Examples are seen at left. At right are two samples of four-lane highways with center stripes you must never cross

command cars to ponderous supply trucks. Of invaluable assistance both to the motorized Army and civilians is the sign system, adopted years ago, to designate U. S. Highways—those highways to which the Federal Government has contributed part of the building costs.

It is an easy thing to remember, but comparatively few people know that under this system odd-numbered routes run north and south, even-numbered ones run east and west. With Route 1 on the east coast and Route 101 on the west, and Routes 10 in the north and 90 in the south intersecting them, all you need are the numbers of two intersecting U. S. Highways to know your approximate location.

Just as important if not more so is the standard U. S. Highway symbol. This is a shield with the highway number painted on it, which keeps auto tourists, military, and commercial drivers on the correct course. In advance of every intersection these standard signs appear and after the intersection confirmatory markers give the driver a double-check on his progress.

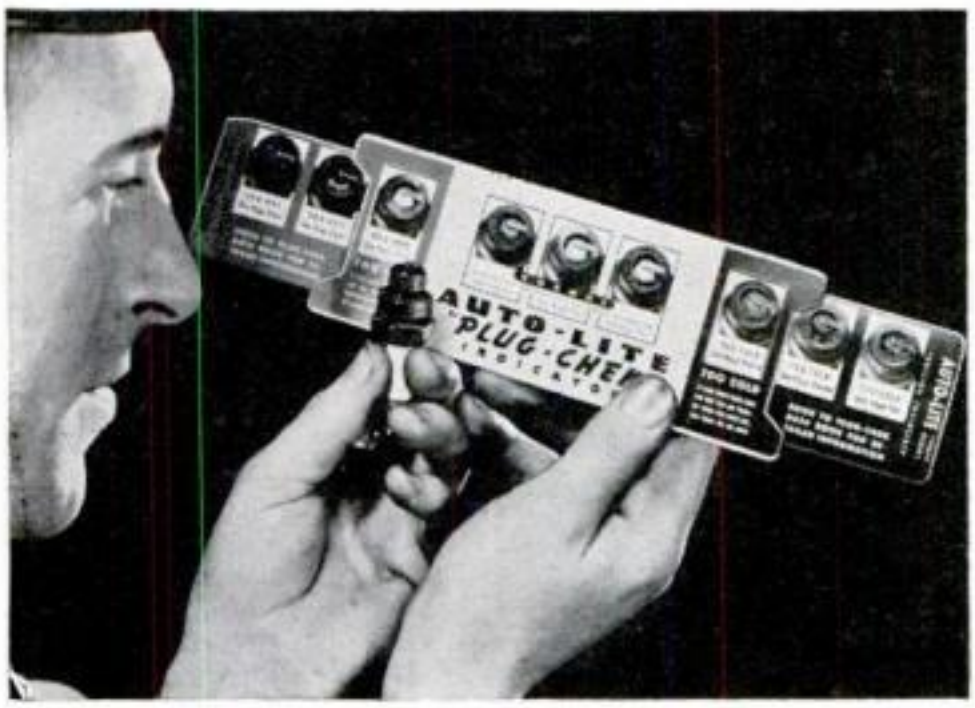
Despite the present confusion of meaning of highway signs there are hopeful indications that the shorthand of the road will become standardized, not only in the United States but in other nations of the Western Hemisphere in the not too distant future.

The seven symbols with which this article began are already standard in about three-quarters of the United States, four provinces of Canada, Mexico, the Canal Zone, Panama, Chile, and Argentina. The recent report of the National Safety Council indicates that 1941 was a year of great progress in the United States for highway-safety legislation. It saw the number of states which adopted the "Manual on Uniform Traffic Control" climb to 21, and the number adopting substantial portions of the "Uniform Vehicle Code" reach 38.

Rules and symbols are fine things to have around, but they aren't much good unless motorists obey them. The first requisite for obeying them is understanding them. The more general the understanding of the system of highway shorthand the better are your chances that you will return home with all limbs intact, your emotions calm, your mind at peace, your nerves steady, and your respect for your fellow-drivers maintained. Utopia may be just around that S-curve.

Auto Ideas

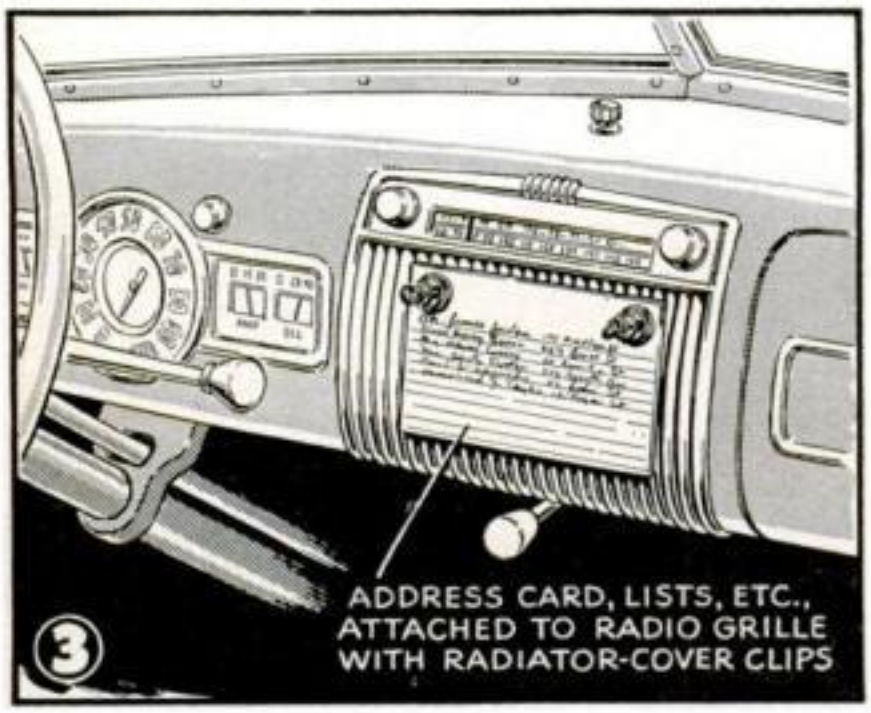
A LIGHTWEIGHT IMPACT WRENCH ideal for loosening "frozen" wheel lugs or nuts makes a handy garage or service-station tool. Weighing but 8½ pounds, the device is made of aluminum alloy wherever the mechanism permits. Its design localizes the steel-to-steel impact without transmitting shock to other parts of the tool and to the operators' hands. The tool, which is designed without gears, can be reversed instantly by operating a lever.

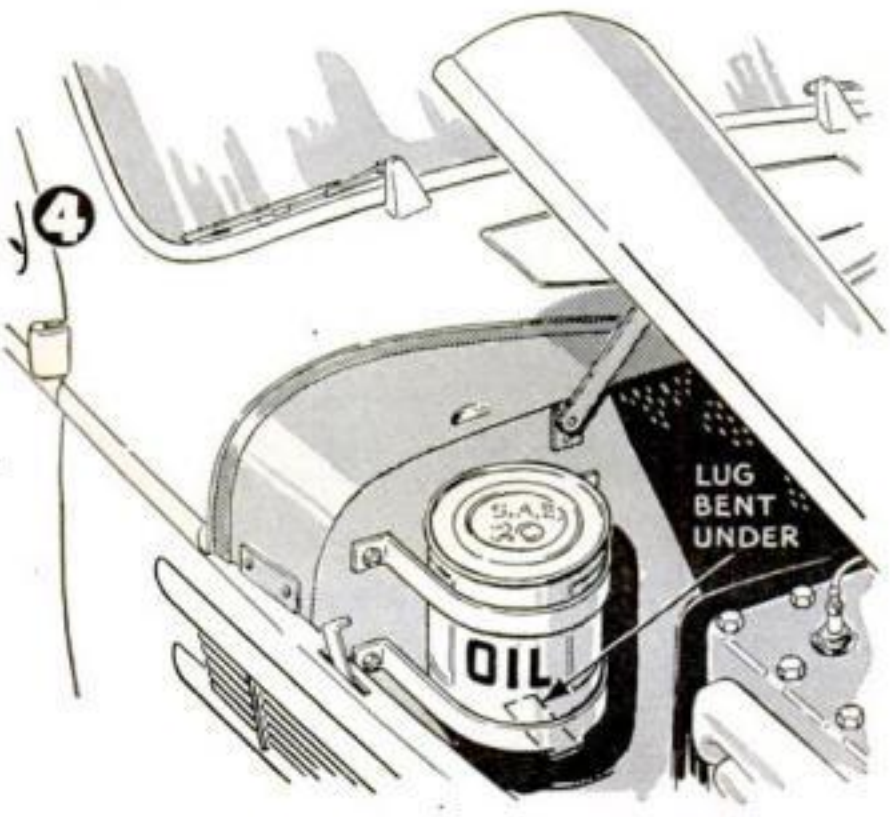


THE BUSINESS END OF A SPARK PLUG can be checked speedily with a new device that looks somewhat like a slide rule but has none of its complexity of operation. The user simply matches the appearance of a plug being checked with one of a number of color pictures on the device. This shows him whether the plug has been operating too hot, too cold, or at the proper temperature. He then refers to a data book supplied with the device, which briefly diagnoses all causes of the plug condition and outlines the remedies that may be applied to put the plug in perfect shape.

PERFECT ADJUSTMENT of the front wheels is made on Chrysler cars, as they leave the factory assembly lines, by means of a device which rotates the wheels electrically, enabling an operator in a pit to measure and correct any deviation from the required angle of toe-in set by the company engineers. During the operation, a check is made on the steering wheel itself to make sure that the single horizontal spoke is level when the front wheels are in the straight-ahead position, thus affording maximum view of the instrument panel for the driver in normal operation.

IDEAS TO MAKE YOUR





1 A DISTINCTIVE CAR MARKER that will instantly identify your parked car no matter how many others are parked in the same lot or field, can be made as shown for attaching to the top of your radio antenna on leaving the car. Because of its reverse curve, a breeze will set it spinning to pick up light reflections at night and make it more noticeable by day.—T. F. S., Jr.

2 A TUBE OF SHAVING CREAM of the lather type, carried in the car on trips, frequently will be useful as an emergency soap for washing the hands during stops at service stations where regular soap either is lacking or dirty. Also, the shaving cream itself remains clean in its air-tight container.—W. W. C.

3 MEMOS, ADDRESSES, AND LISTS can be kept in plain view of the driver by attaching them to the dashboard radio grille by means of spring clips of the type used to hold radiator covers in place. Simply punch suitable holes in appropriate memo cards and insert the clip hooks through them and into the grille. The clips can be obtained at your auto-accessory store.—H. P.

4 EXTRA OIL FOR LONG TRIPS can be conveniently carried under the hood. Make two sheet-metal bands as shown, one having a lug for bottom support. Cut the strips to fit a quart-size or larger sealed can of your favorite engine oil, and bolt the strips to the metal fire wall.—S. R.

DRIVING PLEASANTER

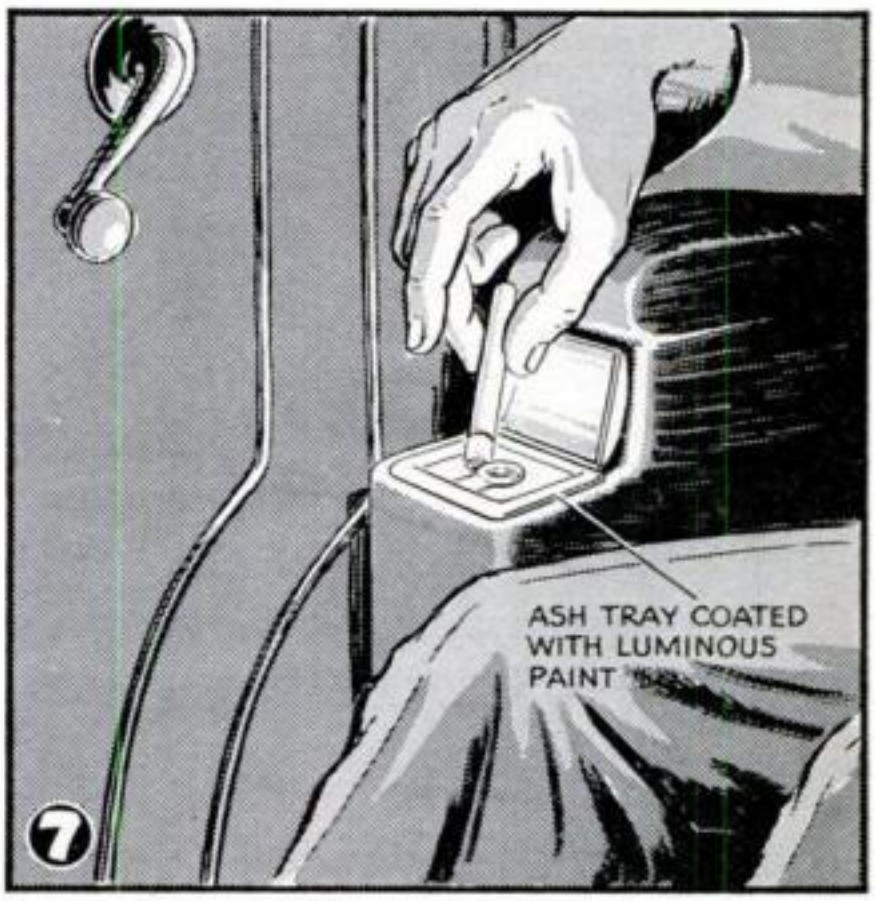
DRAWINGS BY STEWART ROUSE

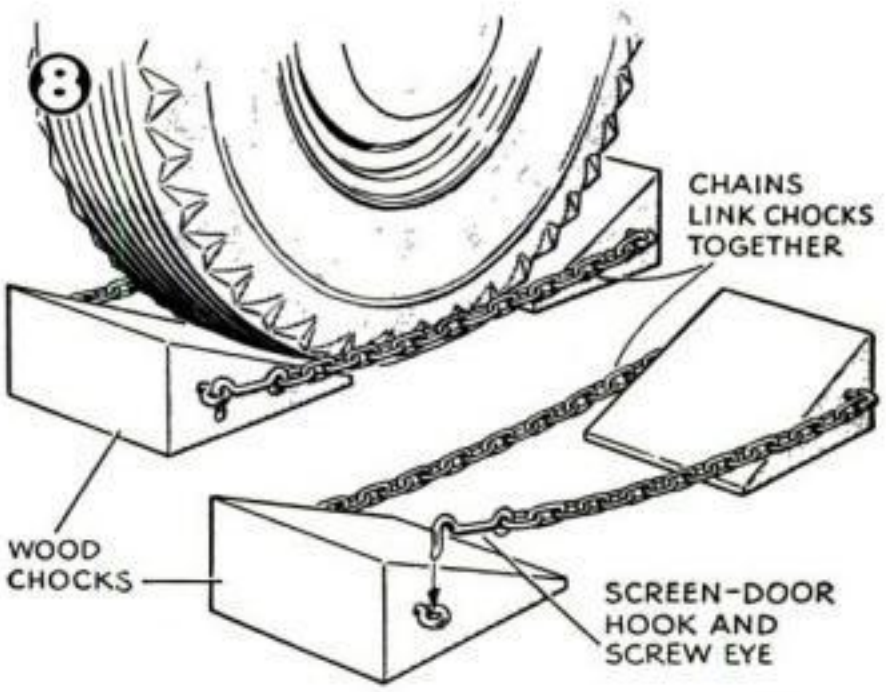
5 A STEERING-WHEEL PROTECTOR for use while you are working on your car and have occasion to turn the wheel with dirty hands is afforded by an ordinary brown paper bag. Put the bag, open, on the front seat before you start work. When you have to touch the wheel, slip your hand into the bag first and use the bag as a glove or mitten.—L. K.

6 BACK-SEAT SUN VISORS can be made from the type ordinarily mounted above the windshield of a car by attaching them as shown to the top of the rear door posts. They screen sunlight from either the rear-quarter or rear-door windows, as needed, giving shade where desired to passengers on the rear seat.—B. T.

7 ASH-TRAY RIMS, coated with luminous paint of the inexpensive variety obtainable at many hardware and paint stores, are easier for cigarette and cigar smokers to find during night driving. The glowing paint gives off just enough light to reveal the position of the ash-tray opening.—M. W.

8 TWIN WHEEL CHOCKS that are easy to place against a wheel have a novel two-way blocking effect. Made from solid wood, as shown, they are held together by a permanent chain on one side, and an easily disconnected chain on the other. The link is made from a screen-door hook and eye which is closed in a jiffy after the chocks have been put in place for a tire change.—C. E. S.





GUS drives a bargain

Trooper Corcoran May Know His Cars. But the Model Garage Proprietor Knows His Cars and His Salesmen, Too. It's Important Sometimes!

By MARTIN BUNN

"HEY, Jerry, what the heck's the matter with you today, anyhow?" Gus Wilson demanded. "You've been sitting there on the end of that workbench for the better part of half an hour without saying ten words."

Trooper Jerry Corcoran, of the State Police, slowly lit a cigarette. "I'm thinking," he said at last.

Gus laughed. "Don't take it so hard," he advised. "Even cops have to think sometimes."

Jerry grinned and pushed his wide-brimmed felt hat onto the back of his head. Then he looked serious again.

"I'm thinking about buying a car," he said. "My old bus is just about done for. I've been sort of hanging on to it with the idea that next year I could afford to buy a new one—but now every one says that maybe next year new cars will be scarcer than hens' teeth. So I've decided that I'd better buy a pretty good used car—and it's got me worried."

"No need to worry," said Gus, "if you go to a reputable used-car dealer and buy a car with a new-car guarantee on it."

"That outfit down near the library is trying to sell me a bus I noticed on their lot yesterday," Jerry said. "It looked to me like a swell buy."

"Paint's cheap," Gus said disparagingly. "And you know their reputation. They're pirates."

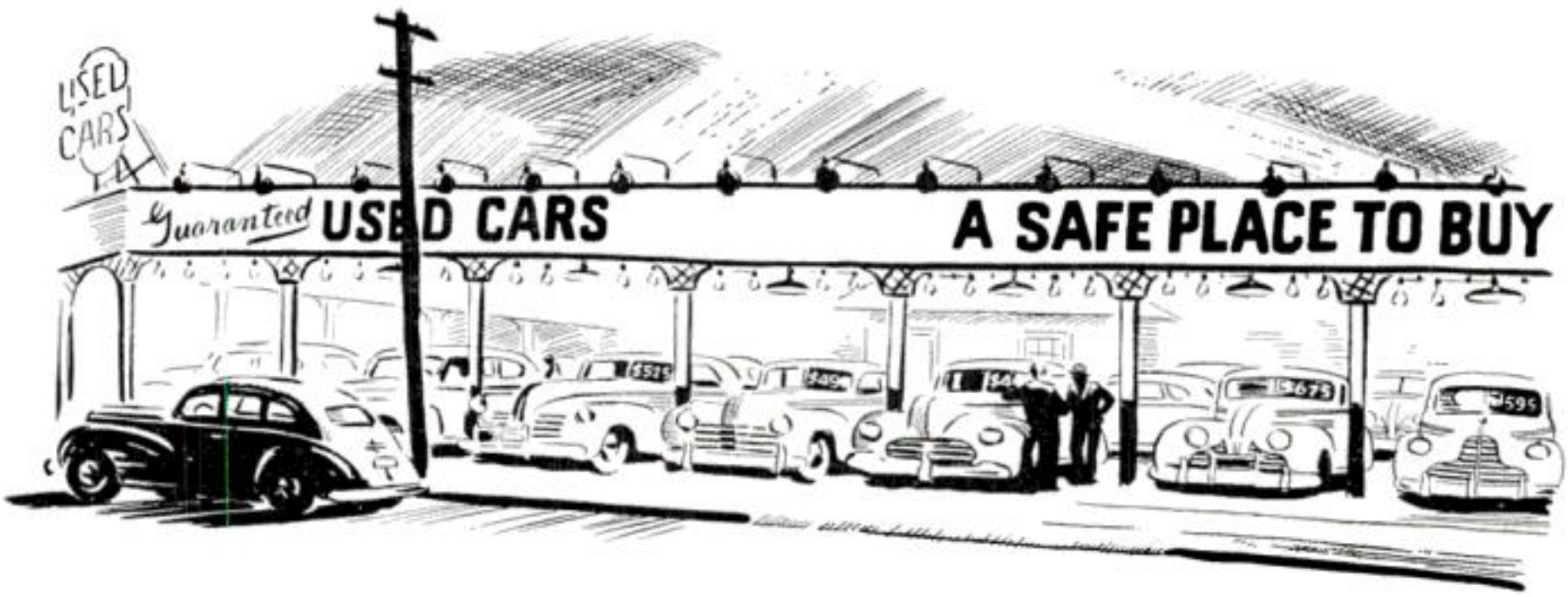
"Yeah, I know that those guys are gyps. But I've been wondering if they'd dare to try to pull anything on me—me being on the cops."

"If J. Edgar Hoover bought a car from them," Gus said, "they'd try to skin him."

Jerry blew another cloud of smoke. "I guess you're right, Gus," he agreed. "I guess maybe I'd better not try to do business with them."

"Oh, I wouldn't say that," Gus objected.

"That outfit down near the library is trying to sell me a bus I noticed on their lot. It looked like a swell buy."



"I was just warning you to watch your step if you do deal with them. Naturally, every car they sell isn't a cluck. You might even get a bargain from them, if you're smarter than they are. Tell you what to do—you go down there to their lot and ask them to let you give that car you're interested in a tryout. Then drive it up here and I'll check on it."

"Say, Gus, that's white of you," Jerry said. "I don't like to make you go to all that trouble, but—"

"No trouble at all," Gus assured him. "I'm aiming to get mine out of the deal. I'll pick out a bum car for you, and then overcharge you for all the repair work you have to have done on it!"

Jerry grinned and got off the workbench. "I'll be back in an hour," he said, "*if* they'll let me take the car out for a tryout."

"Don't tell them I'm going to check on it for you, and whatever you do, don't let that high-pressure salesman named Benny come with you. He does most of the selling for them, and he talks so much and so loud while he's doing it that he drowns out all the knocks and rattles."

In about an hour Jerry was back in the shop of the Model Garage. "I've got the bus outside," he told Gus, "but I've got Benny with it. I just couldn't get rid of him."

Gus laughed. "I had an idea that you wouldn't be able to," he said. "It doesn't matter, after all—I know how we can stall him off. Well, let's have a look at this job."

Instead of going out through the open shop door, Gus led the way through the office. He stopped there and spoke briefly to his partner Joe Clark, and Joe grinned and nodded. Then Gus and Jerry went out to where the car was standing—a 1939-model light sedan of a well-known make.

Benny, a beefy fellow who has a wide and engaging grin and a habit of looking the victims of his guile straight in the eye while he's telling them his biggest lies, jumped out of the car when he saw Gus and came over to him with his hand extended. "This is swell!" he boomed. "What we want most is for our customers to be thoroughly satisfied, so we're always glad when they get a real expert to help them pick out a car. Now, this-here little bus . . ."

"Joe Clark wants to talk to you, Benny," Gus interrupted. "He's waiting for you in the office. He's got to go out in a few minutes. He knows some one who's in the market for a good . . ."

"Sure—sure!" Benny said. "Glad to oblige him! Wait a minute before you start looking her over, Mr. Corcoran. I'll be right back."

Benny dashed into the office. Gus grinned after him. "I told Joe to buttonhole him and keep him in there for fifteen minutes if he had to use force," he said. "Now we'll be able to look over this job in peace."

They went over to the car, and Gus gave its finish and upholstery a quick inspection. "Looks as if it had been given good care," he said, "but finish isn't everything."

"There's only about 15,000 on the speedometer," Jerry remarked. "That's not so bad for two years of driving, is it?"

"It's a little under average," Gus said. "But I don't pay much attention to the mileage figures that speedometers show—it's too darned easy to make them show anything you want them to." He got into the driver's seat. "The feel of the brake and clutch pedals gives you a much safer idea of how far a car has been driven—if they are worn away down the mileage usually is high. These seem to be all right. Let's see about the frame. A car with a sprung frame is a first-class pain in the neck—it drives hard, and it keeps you poor buying tires and gasoline."

He got out of the car, and examined the tires carefully. "Original rubber, I guess," he said. "Their treads are worn some, but you've got to expect that, and they are worn evenly. When they are worn more on one side than on the other it's usually an

indication of a sprung frame, or at least a bent axle or loose wheels."

He looked over the wheels, the hood, the fenders and the running boards. "None of 'em new," he said. "A new wheel or hood or fender on a used car is a danger signal—it may be a tip-off that the car has been pretty seriously wrecked." He checked the springs. "No broken leaves." Then he stepped up on the front bumper, jounced up and down, and repeated his performance on the rear bumper. "Both bumpers are good and tight," he said. "She's O.K. so far, Jerry—but I'll have to drive her a way to really find out about her."

Benny came out of the office. He looked suspiciously at Gus. Then he grinned. Gus grinned back at him.

"I see you've been giving the bus a going over," Benny said. "That's O.K. with me. There ain't a thing wrong with her."

"How does she ride?" Gus asked.

"How does she ride!" Benny repeated. "Why, when you ride in her you feel like you do when you walk on a plush carpet. But don't ask me—I'm trying to sell the job. Try her for yourself."

"I will," Gus said. "After I've blown the tires up to somewhere near their correct pressure. That one's got whiskers, Benny—soft tires to make easy riding."

"Are they soft?" Benny said innocently. "By gum, they are down a little! Put as much air as you want to in 'em."

Gus inflated the tires to normal. Then he got into the car and took the wheel. "You sit up here with me, Jerry," he directed. "You'll be more comfortable in the back seat, Benny."

Benny pushed his way into the front seat. "There's lots of room for three," he said. "I want to show Mr. Corcoran what a big, comfortable car this is.

"Have it your way," Gus told him good-humoredly. He drove down the garage driveway, and then turned north on the road. Then, slowing to a crawl, he drove the right front wheel up on the low curb, and brought the car to a standstill.

"Hey!" Benny yelled. "What you doing—?"

"You know what I'm doing as well as I do," Gus said. He got out and again opened and closed each of the car's four doors. "If the doors stick when one wheel of a car is higher than the others," he told Jerry, "a loose frame is allowing the body to twist. As you see, these doors don't stick. But there's one more check I'd like to make. Hey, Benny, climb over behind the wheel, will you, and drive down the road slowly for a block. Then come back into the shop."

"Sure," Benny said. "You're just wasting time, though." Then he drove slowly down the road.

Gus watched the car closely. The springs obviously did not sag, and the wheels tracked perfectly. "That's fine, he told himself. "Now we'll see about the engine."

When Benny drove into the shop, Gus raised the hood and began taking out the spark plugs and examining them. "That's a new one on me," the salesman said. "What's the big idea?"

"On a six-cylinder engine," Gus explained politely, "the No. 1 and No. 6 plugs normally show a little more carbon than the other ones do. If one of the other plugs shows more carbon than No. 1 and No. 6, the chances are that its cylinder is scored, or that it has bad rings, or maybe a bad valve. This engine seems O.K., but I'll just check it with my vacuum tester—*if* you don't mind."

"Oh, I don't mind," Benny said. "I'm enjoying all this. Maybe I'll learn something useful. You never can tell!"

Gus laughed, and carefully checked the manifold vacuum. "Readings are O.K.," he reported when he had finished. "Now let's take a ride."

He took the wheel again, and drove toward the business section of town. Traffic soon became sticky, and he did a lot of stopping and starting. Presently he drew into the curb, got out, moistened his forefinger, and touched it to each brake drum of the car. "Brakes are all right," he told Jerry, "because each one is just as warm as the others."

He drove on, and turned down a side street on which there was almost no traffic. With the engine running at little more than idling speed he shifted into low gear, and for a few seconds held a finger on the gearshift lever. Then he shifted into the other speeds, including reverse, and did the same thing. "No vibration at any speed," he said. "That means that the gears aren't badly worn, and that their teeth aren't burred. The clutch is all right, too—doesn't slip or grab. I can hardly believe it, Benny, but I'm be- *(Continued on page 218)*

GUS SAYS:

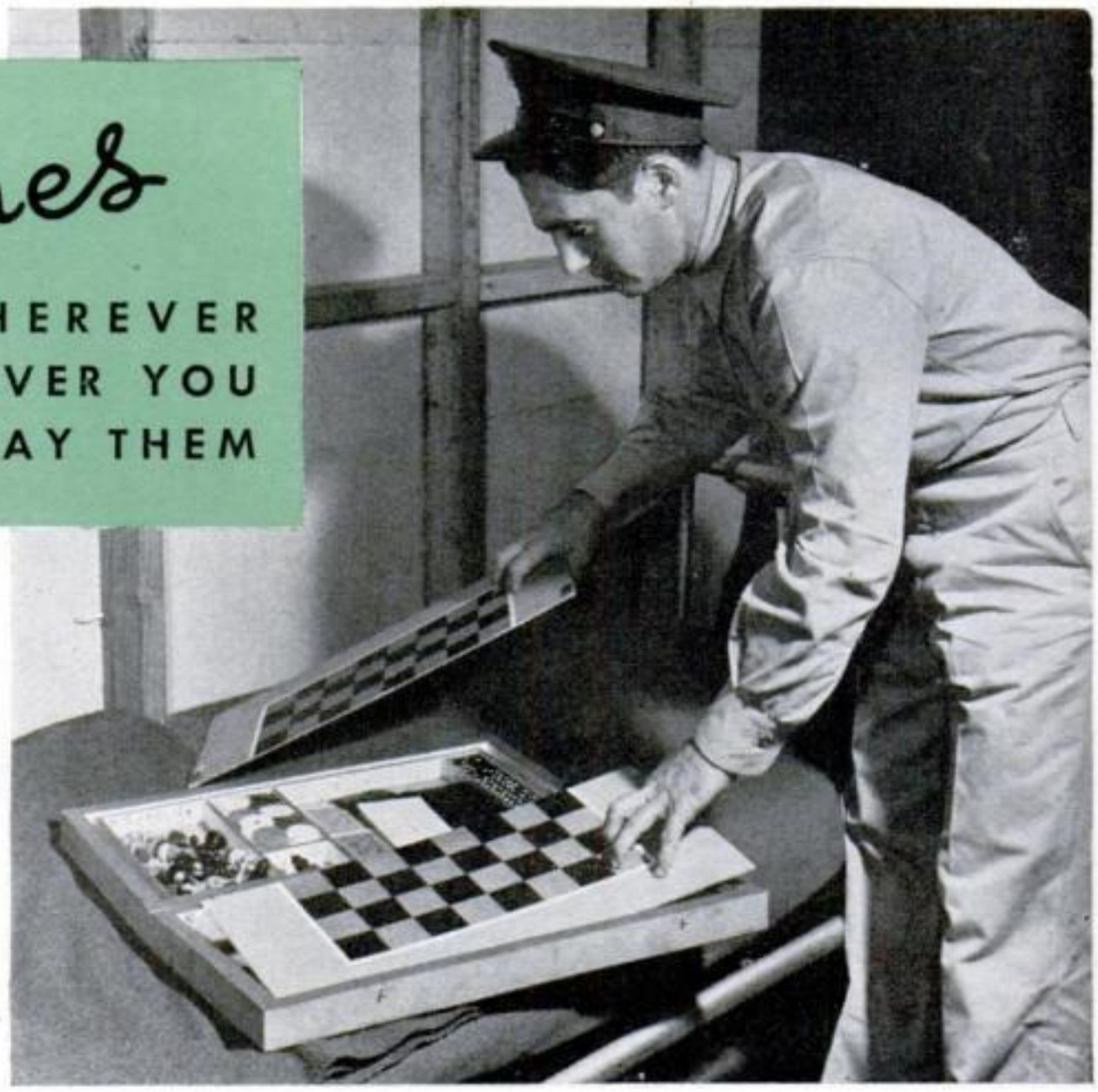
It's patriotic to save gasoline by slower driving just now, but it is smart—always! Because driving at 35 instead of 55 will save almost enough money every five years to pay for a brand-new automobile!

HOME *and* WORKSHOP

For men in service and industrial workers away from home, this simply made portable game kit provides endless recreation

NEXT PAGE

Games ...WHEREVER AND WHENEVER YOU WANT TO PLAY THEM



Time for a game, but not enough to make use of the facilities of the camp recreation center. This soldier gets out a game kit, and he and his friends are all set for an hour or so of cards, backgammon, checkers

A PORTABLE KIT DESIGNED ESPECIALLY FOR MEN IN SERVICE, BUT EQUALLY GOOD FOR CIVILIANS

By Charles and Bertram Brownold

MEN in Army camps and civilians working under high pressure in defense industries stand in great need of adequate recreation. They must have their games. It is, fortunately, quite easy to provide facilities for a number of games by constructing the type of combination playing board and game kit illustrated. This is a compact, portable, self-contained unit for chess, checkers, backgammon, cards, dominoes, and other games.

The kit is constructed in two halves, each being a shallow box. These are hinged together to form the playing board when they are open. Unlike other folding game boards, they can be locked rigidly in the open position so that they provide a firm, level playing surface which can be supported on the knees of the players, if necessary, without any danger of "breaking" at the hinge and upsetting. This is a great advantage in such places as tents or barracks, or on a train journey or an outing, when there is no table available.

The equipment for the games is packed in a tray, which fits into one section of the playing board. The other half of the board may be used for holding additional games, magazines, cigarettes, or other small articles.

When closed, the game kit is a box 3¼" by 11½" by 23" and is carried like a small suitcase. The sides are ¾" thick, and are preferably of maple, birch, or some other hardwood. The top and bottom are made of ⅛" thick plywood or pressed composition wood.

The simplest way to assemble the box is to cut two pieces ¾" by 3 3/16" by 23" and two pieces ¾" by 3 3/16" by 10" and glue and nail them together to form an open frame. Drill holes for the nails to avoid splitting the wood, and be sure that the corners are perfectly square. Then glue and nail on the top and bottom, and plane the edges of the plywood exactly flush. The completely inclosed box thus formed can then be sawed in half to form two shallow boxes. A circular saw may be used, if one is available, or a line can be drawn around the box where the joint is to come, and a handsaw used to split the line. The sawed edges are then dressed smooth with a plane.

There are, of course, other ways to make the game board. We wished the first one

we constructed to be very strong and workmanlike, so we used dovetail joints. As the stock we were using happened to be ¾" by 1½" maple, we had to make the two sections separately. We laid out the dovetails on the ends of the eight pieces with the aid of a sheet-metal template, thus assuring accuracy and speeding up the work.

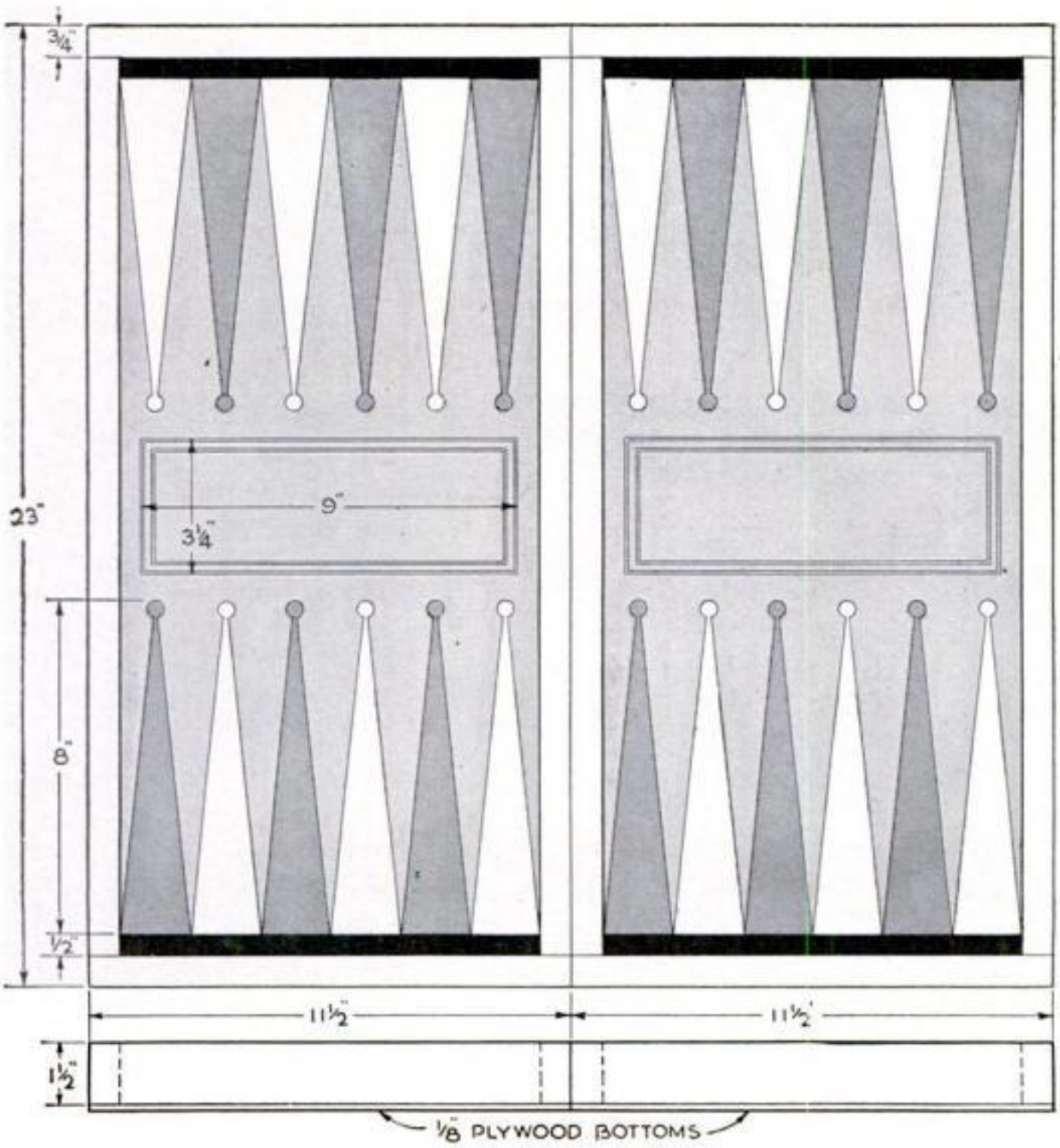
When glued joints are used, without nails or screws, it is important to clamp the parts firmly until the glue sets. If regular clamps are not available, it takes only a few minutes to improvise a jig in which the frame can be clamped by using wooden wedges.

Before the two halves are hinged together with a pair of 2" narrow butts, it is necessary to install the device for locking the board in the open position. This consists of two bolts made from ¼" diameter steel rod. Each is 10¾" long and slides in a piece of brass tube fastened to the inside of one of the boxes as indicated. The end of each bolt slides through holes in the hinge sides of the two sections and passes into another tube similarly placed in the other box. The tubes and holes must, of course, be lined up accurately or the bolts will bind.

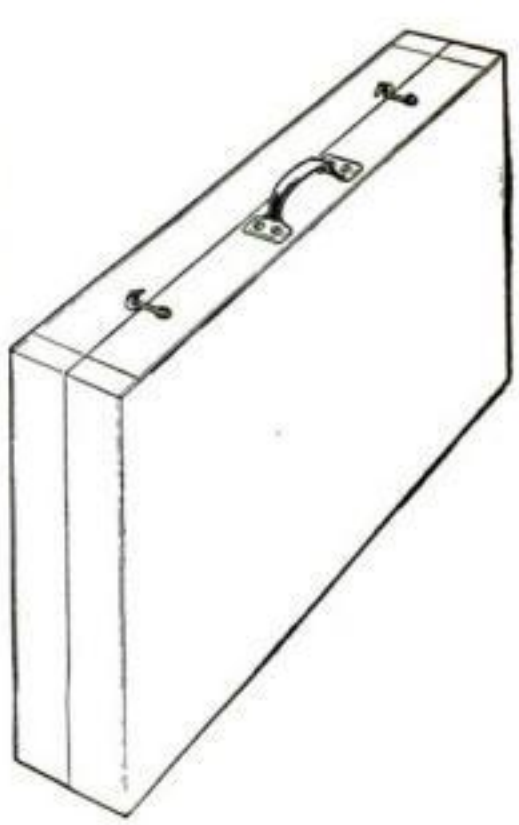
To prevent the bolts from falling out, pins are driven into holes drilled near their ends. When in the withdrawn position, each bolt is held in place by a catch of spring metal, which engages a shoulder cut or filed in the rod. The bolts cannot slide until the catches are moved. In the absence of a lathe or other convenient means of shaping the ends of the rod, a breast drill and file can be used. Support the drill in a vise and the end of the rod to be shaped in a jig, which can be made by boring a hole of the proper size through a fairly heavy block—one which can be held steady.

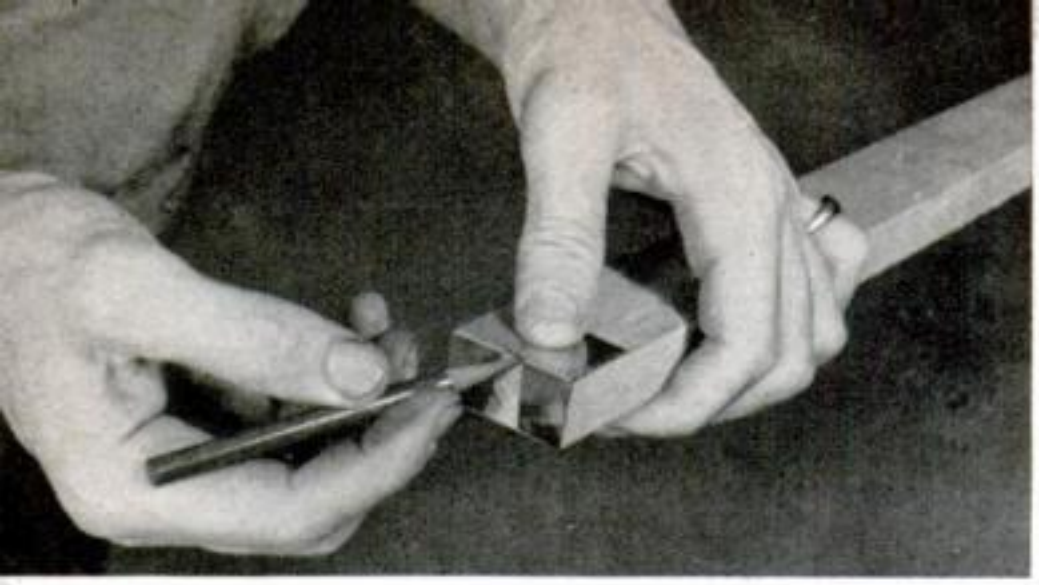
The tubes in which the bolts slide are each held in place by two pipe straps. It is better to make the pipe straps than to buy commercial ones because those made in your own shop can be cut a trifle too small and bent so as to hold the tubes against the side of the boxes very securely when the screws are tightened.

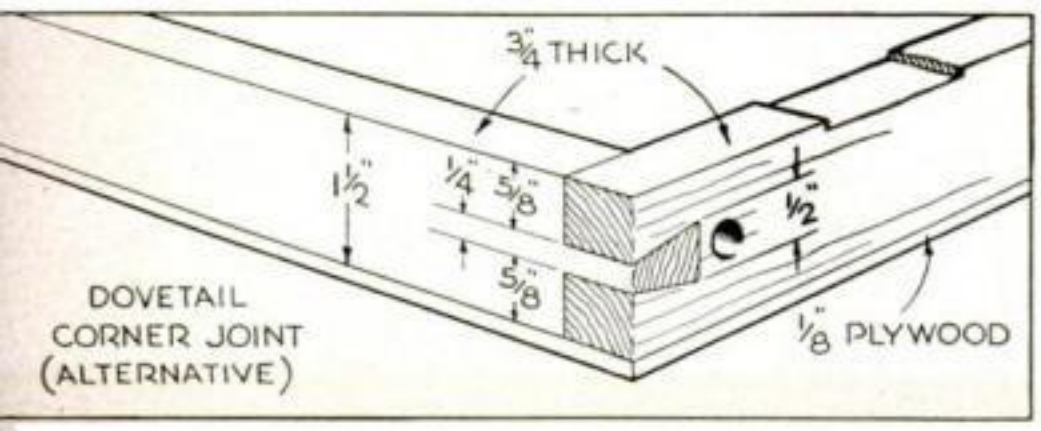
The tray to hold the game equipment is made with sides of ¼" hardwood and a bottom of ⅛" plywood. Overall, it is 1¼" by 9½" by 20". In any case, make the tray to fit without too much play and be sure it is at least as deep as the diameter of the base of the largest chessman in the chess set that is to be used. Partitions to keep the equipment in place may be dadoed in or simply nailed in wherever required, as illustrated. *(Continued)*



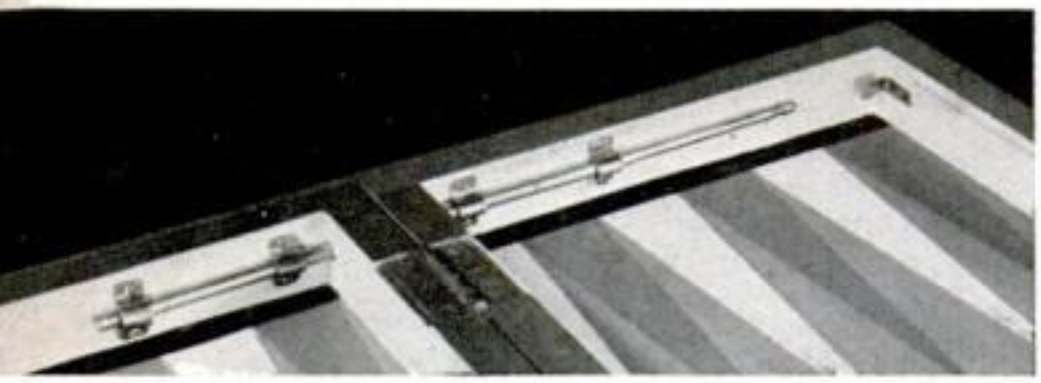
Laid out inside the case is a backgammon board. Care must be taken that dimensions given in the drawing for the points are followed accurately or there will not be room for the chips. Below, the folded kit resembles a suitcase

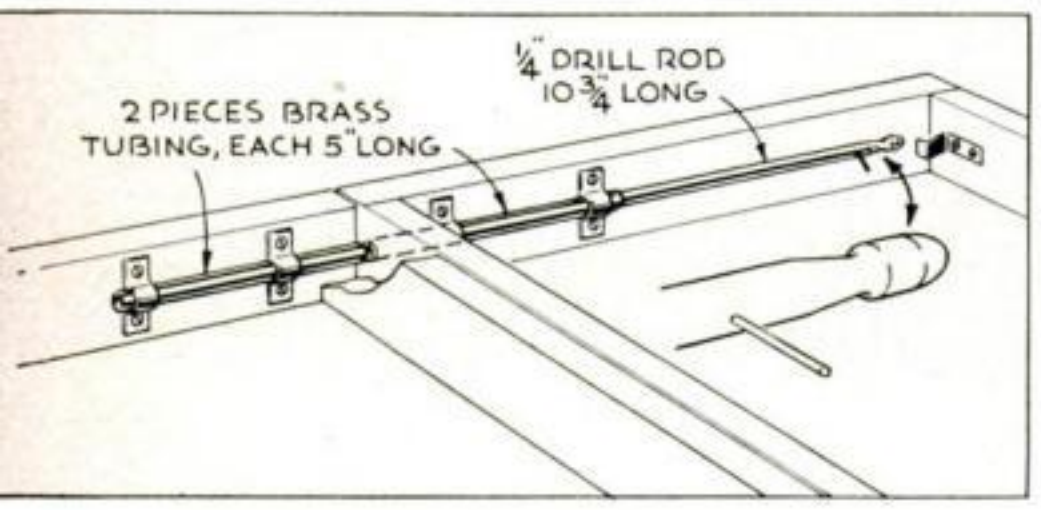






With a metal template, strong dovetail joints can be laid out accurately, but nails and glue will do





Each half of the case is fitted with a plywood cover, which wedges in tightly and can be pulled out by means of finger holes cut for the purpose. The cover for that half of the box containing the equipment tray rests on the side of the tray, while the cover for the other half rests on two strips of 1/8" plywood nailed to the inner sides of the box.

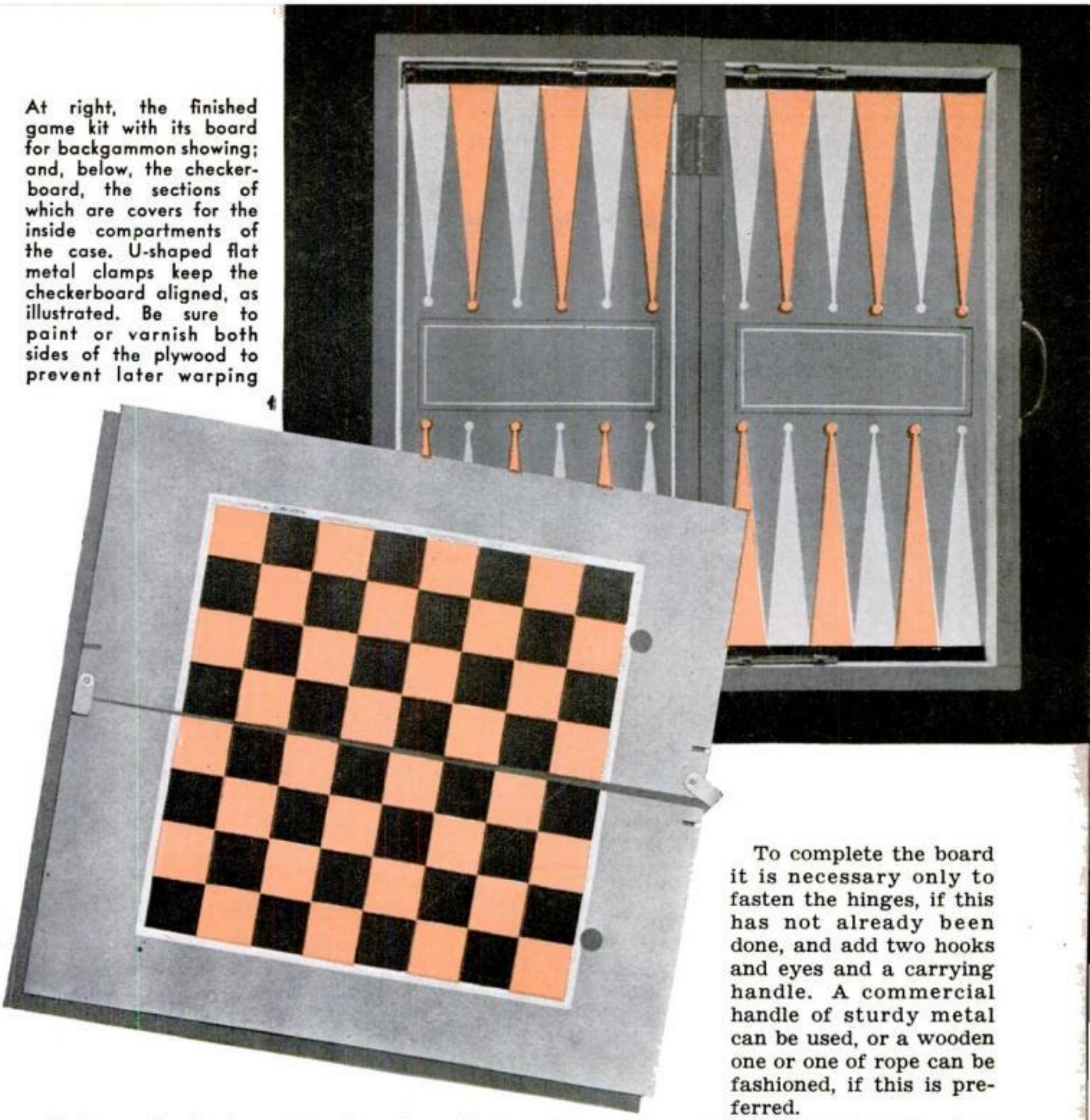
Since the two covers are used as a checkerboard, it is desirable to provide some means of holding them in alignment. This can be done by providing two latches of thin brass or tin, as shown. The slots for the latches should be cut before the boards are painted, but the brass pieces should not be riveted on until afterwards. A standard checkerboard is painted on one side of the cover pieces, and the other side can be painted, shellacked, or varnished, as preferred.

The interior of the box is painted with the conventional backgammon markings. The exterior can be finished in any color desired, but for hard usage it is well to use khaki, olive drab, or Navy gray—colors especially suitable if the kit is to be used by soldiers or sailors. The edges of the boxes may be painted red or any bright color to brighten up the ensemble.

Since the equipment tray covers are removed from the case for playing chess or checkers, there are playing surfaces at hand for two different games to go on simultaneously. Thus, while one set of players may be using the checker board, another

At left is a rod-and-tube device—one on each side—for locking the case open when no table is available. The drawing shows assembly details

In the equipment tray below are chessmen, poker chips (used also for checkers and backgammon), dice, dice cups, cards, score pads, and dominoes



At right, the finished game kit with its board for backgammon showing; and, below, the checkerboard, the sections of which are covers for the inside compartments of the case. U-shaped flat metal clamps keep the checkerboard aligned, as illustrated. Be sure to paint or varnish both sides of the plywood to prevent later warping

will have the backgammon board on the inside of the case, or the cover of the case itself, available for backgammon, cards, or some other game that does not require the use of a checkerboard.

In laying out the playing surfaces it is well to bear in mind the following: Each of the 24 backgammon points must be sufficiently wide at the base to accommodate one chip, and each must be long enough to accommodate five chips, as shown in the drawing. The width of each half of the board (inside dimensions) must accommodate six such points.

Markings for additional games can be painted on the inside of the two covers, on the bottom of the equipment tray, and also, if desired, on the exteriors of the two halves of the case. Thus such games as parchesi can be added.

To complete the board it is necessary only to fasten the hinges, if this has not already been done, and add two hooks and eyes and a carrying handle. A commercial handle of sturdy metal can be used, or a wooden one or one of rope can be fashioned, if this is preferred.

The equipment to be stored in the tray consists of the following: Poker chips, which in this case are also used for playing checkers and backgammon. Chessmen. Dominoes. Two decks of cards with backs of different colors. Two folding dice boxes. Two pairs of dice, one white and the other red. A score pad with contract bridge values and a pencil.

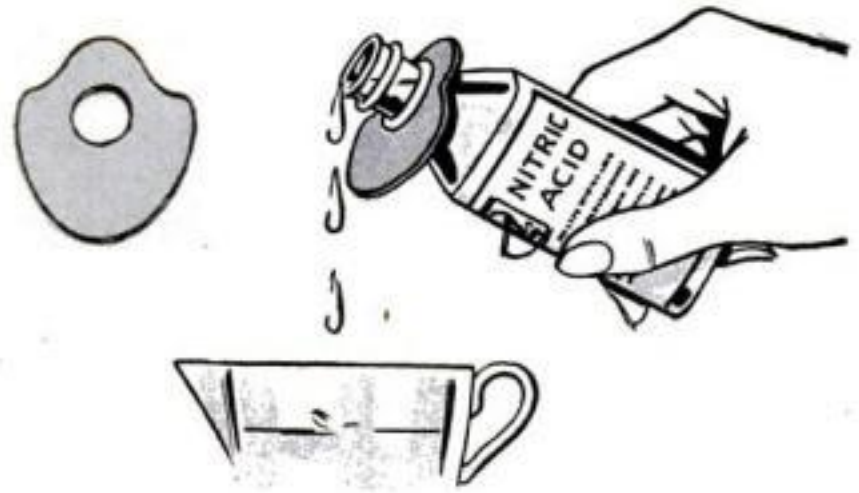
With this equipment you are never at a loss as to how to spend a leisure hour. You have what amounts to a well-appointed little game room, all packed within the space of a small suitcase and ready to be set up anywhere at any time.

Designs for a large game cabinet and other recreation-room furniture will be found on pages 186-189 of this issue. Refer also to P.S.M., Jan., '42, pp. 162-165.

KEEPING THE

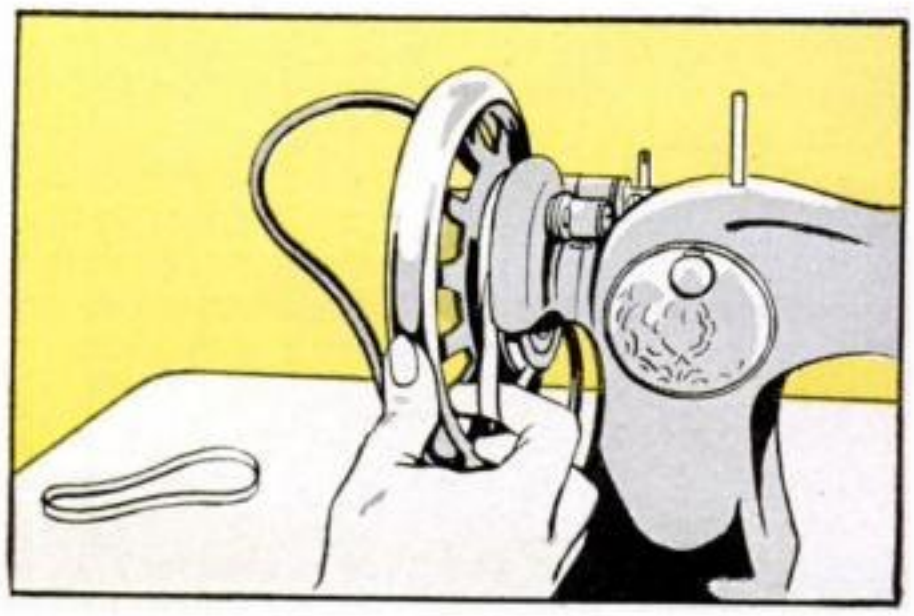
To eliminate puddles on the bathroom floor and the wetting of mats, towels, or clothing with water splashed through the gap between shower curtains, clip the open edges of these together in two or three places with spring-type wooden clothespins

A hollow rubber ball of appropriate size, cut in half, makes two convenient hand grips for loosening stubborn jar caps, and also for screwing them on tightly. If necessary, the second half of the ball may be used to grasp the bottom of the jar



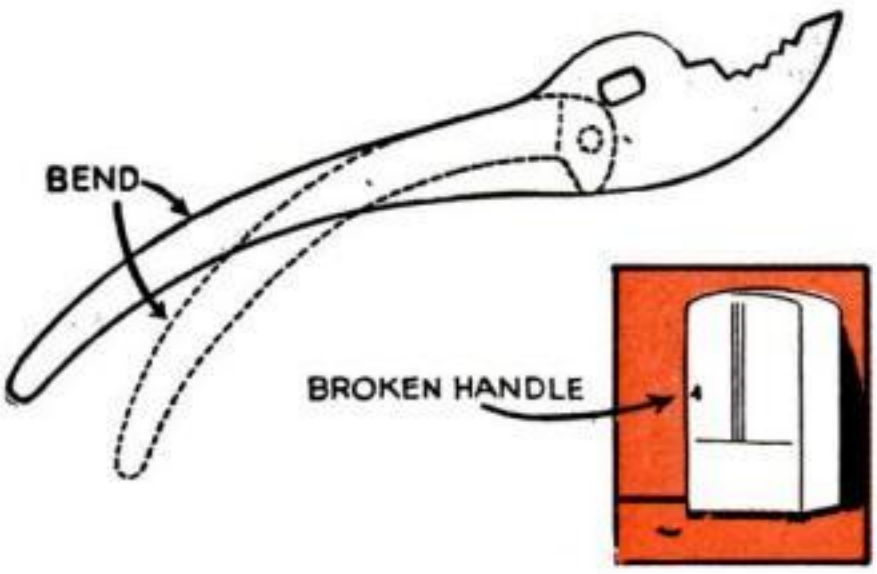
When acid is poured from small bottles that have no pouring lip, a few drops usually run down the side. To protect the fingers and keep acid from dripping on the table, cut a collar as shown from inner-tube rubber and stretch it on over the neck. This will also identify such bottles in the dark

It pays to keep a big cookie sheet in the bottom of the oven. Should the juices of food run over during baking, it is much easier to take out and clean the sheet than it would be to scour the oven

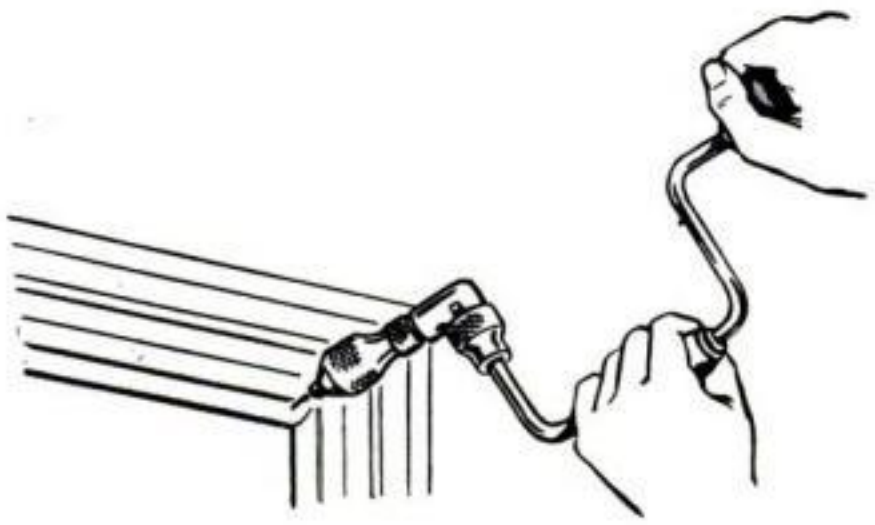


Few things are more annoying than a loose sewing-machine belt. An easy way to make it grip without cutting and shortening it is to stretch a few big rubber bands over the small pulley as shown above

HOME SHIPSHAPE



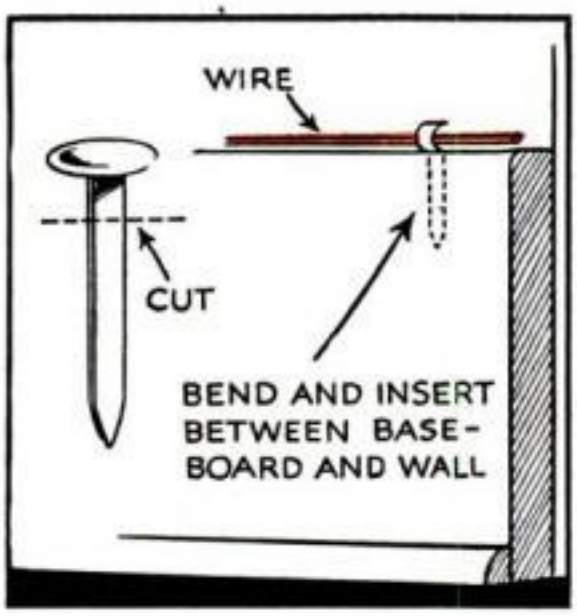
You can replace a broken refrigerator handle by grinding a new one to shape from one of the legs of a pair of cheap malleable-iron pliers. Drill the pivot hole and bend the piece as necessary to clear the door. Finish with white bathtub enamel



A projecting finishing nail or one from which the head has been torn can be removed without damaging trim molding or other material in which it may be embedded. Simply tighten the chuck of an ordinary hand brace over it, twist the brace back and forth, and pull on it at the same time

Light, strong ladders for occasional or emergency use are quickly made from 1" by 2" furring or roofing laths. Nail two pieces together at one end for each side rail, and nail rungs across the outer of these. Spring the inside ones inward at the middle and nail the rungs fast to these also

Small rubber-headed tacks make effective silencing bumpers for table drop leaves, and prevent marring the finish on the legs



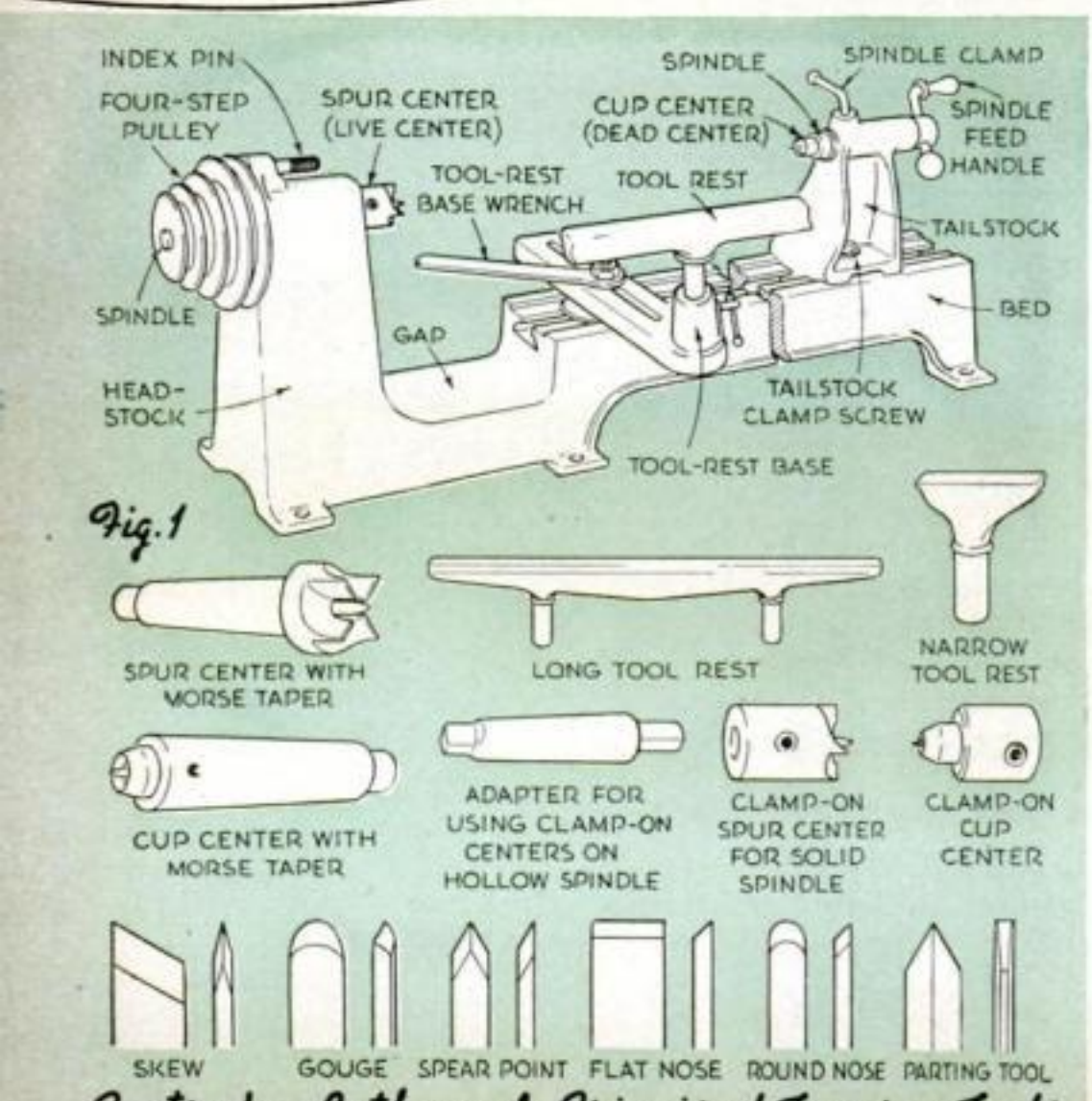
Aerial and doorbell wires can be held along baseboards with clips made of paper fasteners. Insert these between wall and baseboard

To keep a drawer neat, boxes for trinkets and other small articles may be thumb-tacked to the bottom in any desired arrangement

Peter the Great had two early loves —the Russian navy, which he created, and woodwork—and he almost made them interchangeable. As a boy, he became expert with the lathe and other woodworking tools, and as czar soon developed a keen interest in building ships (he ascended the throne at the early age of ten). He even made a journey to Holland, where he worked as a common shipbuilder to acquire a competent knowledge of the art. To assure ample wood for his hulls, he forbade felling oaks without license, and established a seedling nursery to aid reforestation

A Royal Hobby

EDWIN M. LOVE TAKES YOU STEP BY STEP THROUGH THE ELEMENTS OF WOOD TURNING



Parts of a Lathe and Principal Turning Tools

THE magic of motion and keen-edged steel shapes a whirling block of wood as easily as the potter's thumb molds clay. Turning, one of the oldest woodworking arts, has been the hobby of kings, and remains today a popular type of craftwork. More than any other power tool, the lathe is in itself capable of producing finished pieces. By mastering a few basic cuts, the beginner will find the development of his skill in this craft as easy as it is fascinating.

What is the first step in spindle turning?

The stock must be prepared for mounting in the lathe, the principal parts of which are illustrated in Fig. 1. Find the axial center at both ends by diagonals or, if the piece is round or irregular, use hermaphrodite calipers

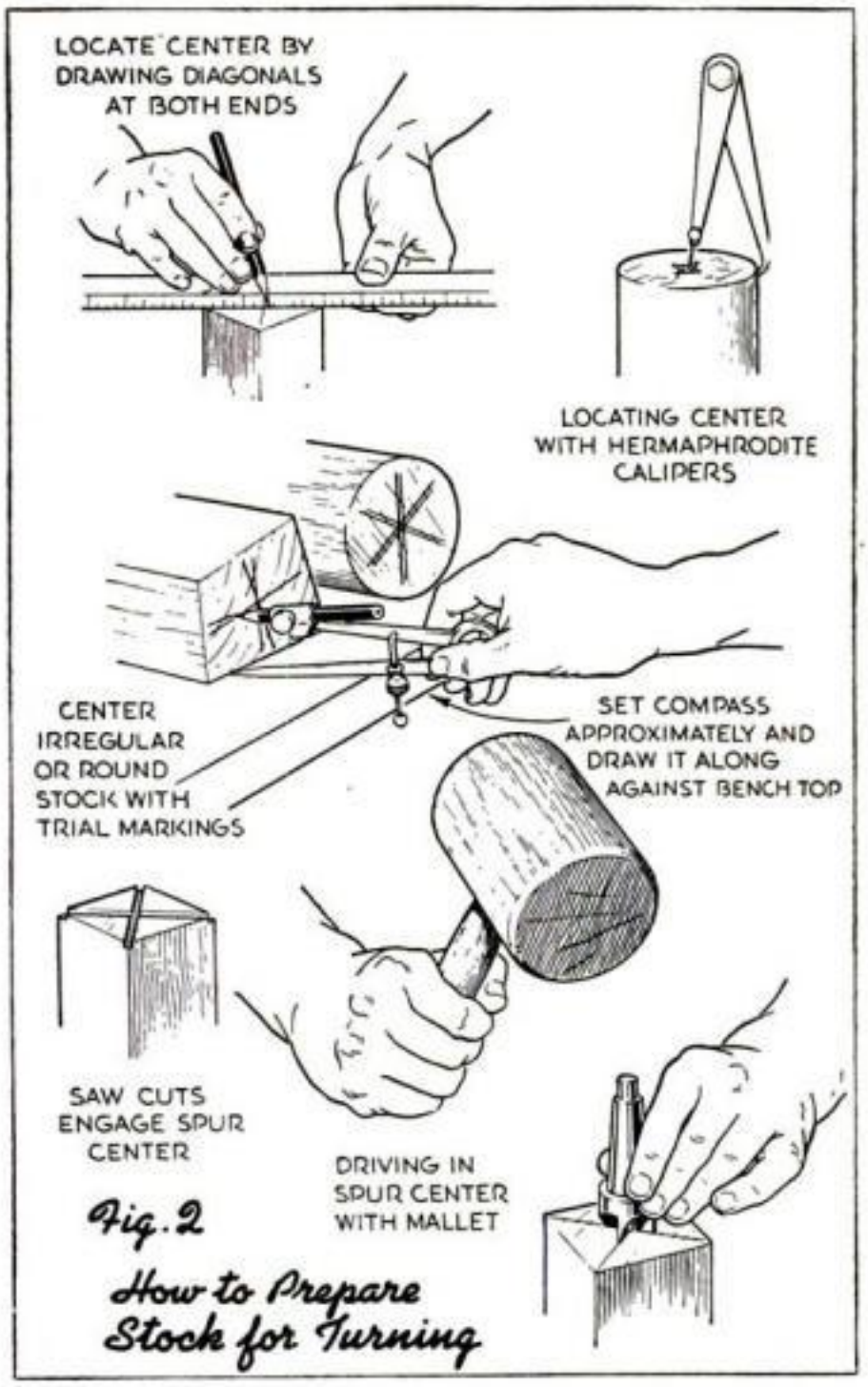


Fig. 2

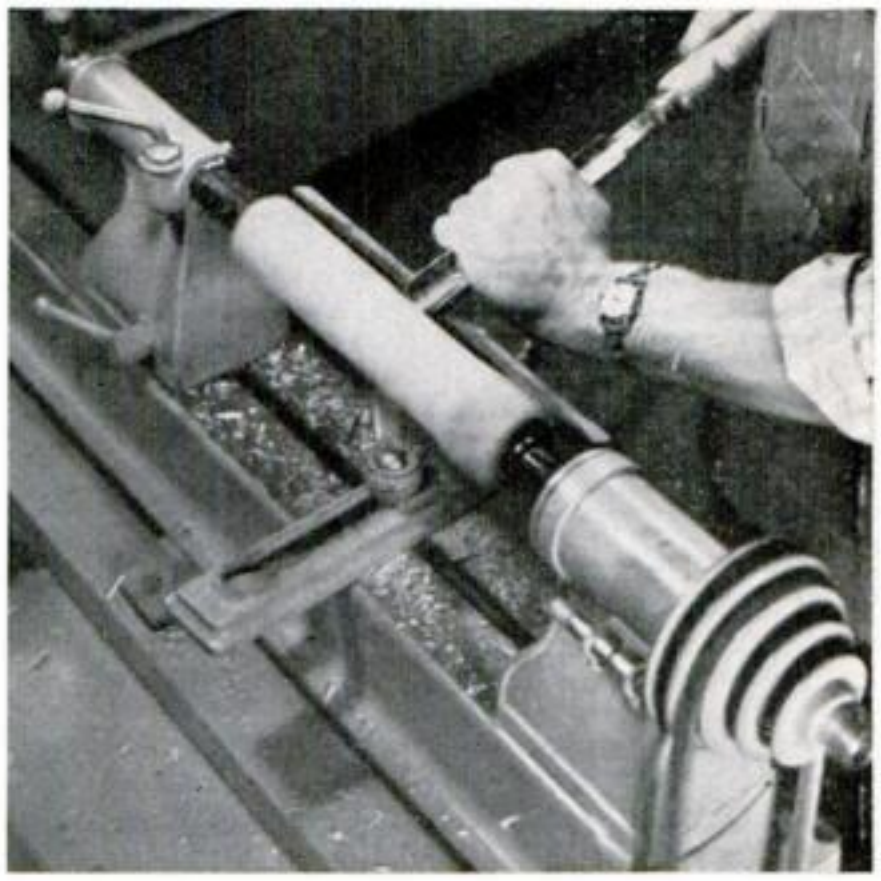
How to Prepare Stock for Turning

or a compass as shown in Fig. 2. Shallow saw cuts along the diagonals afford a positive grip for the spur center, or it can be driven in with a mallet.

Drive in the cup center at the opposite end, then mount the work in the lathe, sliding the tailstock up to engage the cup center. Turn the tailstock spindle until the piece turns freely without end play, and lock. In mounting heavy work, keep the spindle well within its housing. Lubricate both wood and dead center with oil, wax, or cup grease. Clamp the tool rest about ⅛" away from and ⅛" above the center line of the work. Turn *by hand* before switching on the motor to check clearance.

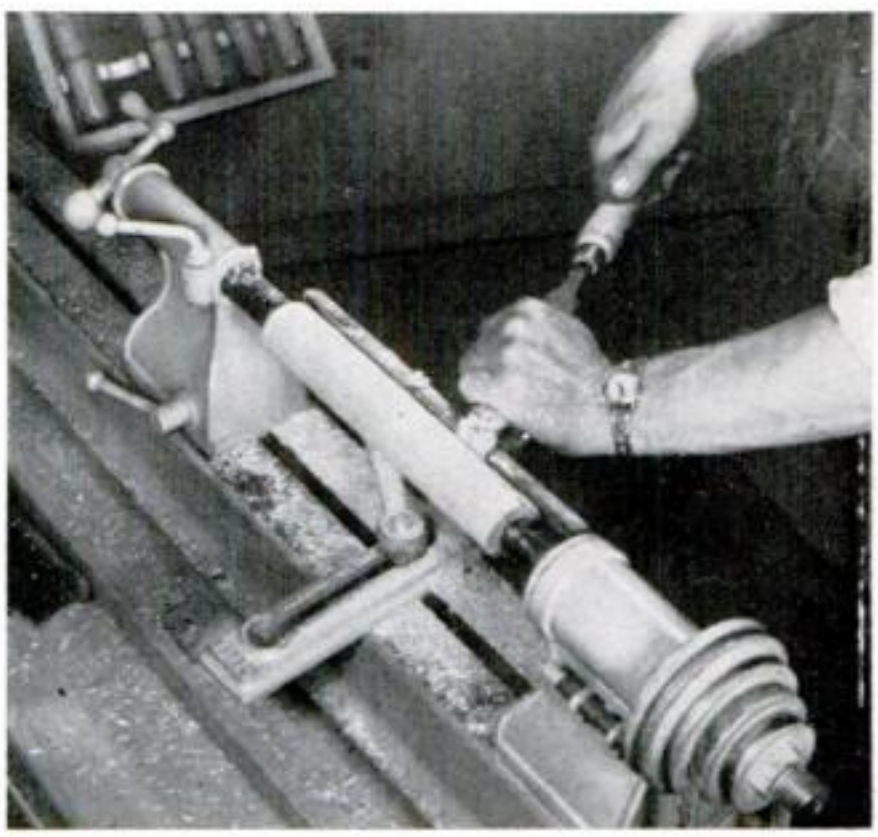
What is the action of lathe tools?

Either scraping or cutting. Scraping is a slow process, dulls tools quickly, and is likely to leave a rough surface. Cutting leaves tools keen longer and, skillfully done, produces smooth surfaces that require little sanding. However, scraping is so easy that it offers no problem even to the most inexperienced, and therefore affords a way to turn out finished work immediately. But there is real satisfaction in using a lathe in the generally approved manner. For this



Rough off the corners with a large gouge. Nick deeply at intervals to prevent long splinters

In turning with a skew chisel, hold bevel nearly tangent to the cylinder, cutting just above heel



To scrape, hold a wide skew or square-nose chisel horizontal, with the edge a little above center

POINTERS ON SPINDLE TURNING

1 Never set the tool rest below the center line of the work.

2 Rotate work by hand to check clearances before using power.

3 Stand aside when starting the lathe the first time with a newly mounted piece of work in it. Shut it off immediately if the piece rattles on the dead center.

4 Use low speed for all rough, irregular work but the smallest.

5 Save time by rough-turning all parts with a gouge.

6 Start cutting a short distance from the ends. Work toward the ends so the tool won't catch.

7 Keep tools razor sharp. Dull tools waste time and produce poor work. Time spent in whetting turning tools is time saved.

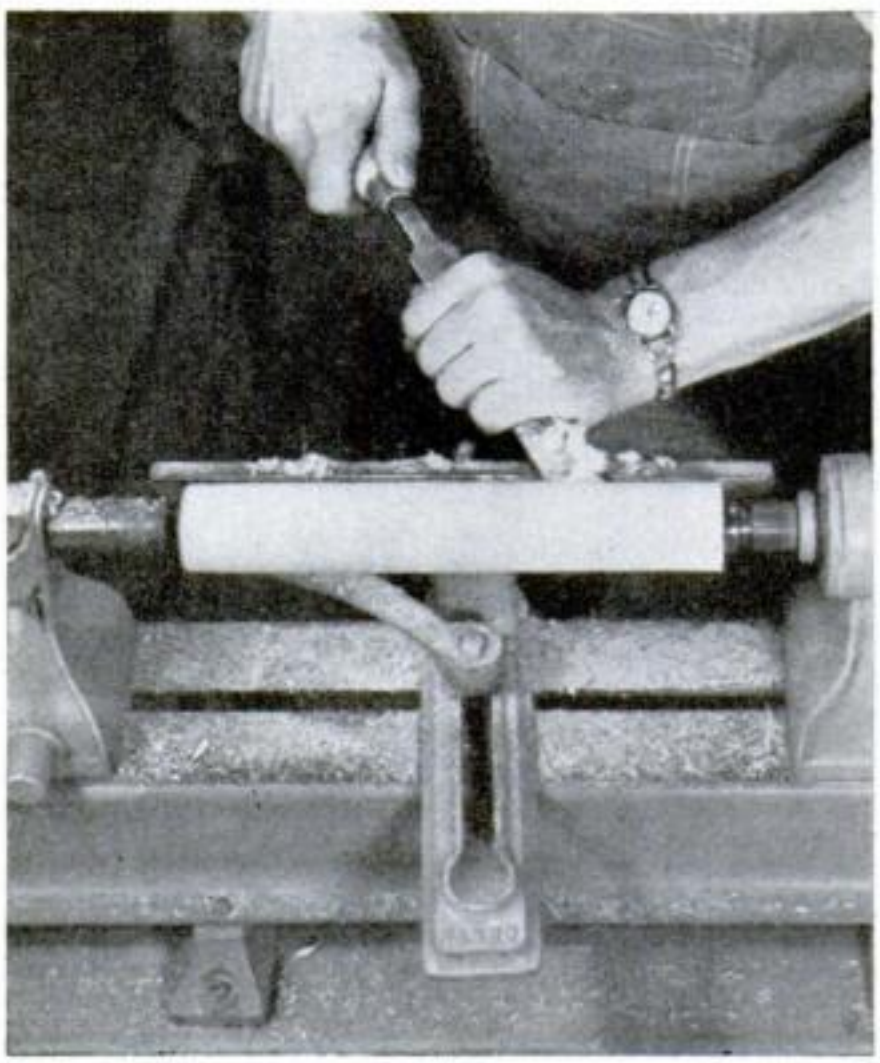
reason, if for no other, the serious craftsman will practice shearing cuts until they become second nature.

How is turning begun?

The stock must first be turned to a smooth cylinder. Large work should be dressed octagonally on the jointer or by hand plane before it is mounted. Always shift to the lowest speed for rough-turning.

To use a scraping cut, hold the large gouge flat on the tool rest as in Fig. 3. Tilt the tool toward the right along its axis to make it throw the chips to one side. Start the cut about 2" from the tailstock end, and work to that end. The second cut is started about 2" to the left of the first, and carried in the same direction to merge with the first. Continue in this way to within about 2" of the live center, at which point the gouge should be rolled to the left and the final cut made in that direction. Do not try to rough-turn in one operation, as this will tear long splinters from the corners. A second lighter cut

Another view of the scraping operation. Slide the chisel horizontally along the work. Keep the edge parallel to the surface and use moderate pressure only. The long tool rest is especially convenient



Marking the cylinder into divisions for various types of cuts is done while the work turns. Hold a scale on the top of the tool rest, and press a pencil against the cylinder at the proper points

should remove heavy ridges and produce a rough cylinder.

Although more difficult, the method of making a shearing cut, as distinct from scraping, is also easily learned. The position of the tool is shown in Fig. 4. The gouge is no longer in the horizontal plane, but sloped toward the top of the work almost tangent to the cylinder to be turned. The edge is advanced in the direction of the cut slightly farther than the handle, and the tool again rolled to that side to throw off the chips.

What is the next step after rough-turning?

A skew chisel (Fig. 1) is used to scrape the cylinder smooth. Rest the tool flat on the tool rest as in Fig. 5, a little above center and parallel to the axis of the work, and slide it along the cylinder. An ordinary wide chisel can also be used.

The shearing cut with the skew chisel is made by holding the tool tangent to the work, like the gouge. Rest the beveled edge on the work, then slide the chisel back and downward until the center of the edge begins to cut. Again the cutting point should be slightly in advance of the handle (Fig. 6). Do not allow the heel or the toe to cut, as it will gash the work. To cut toward the live center, simply turn the tool over in the same relative position. Use the highest lathe speed compatible with the size of the work. If spiral ridges occur, hold the blade more nearly at a right angle to the axis.

What are the steps in cutting a bead?

Score penciled division lines with the toe of the skew, then use the heel, starting in a flat position, as in Fig. 7, to make a deep vertical cut. Gradually work around to a more vertical position as the heel sinks into the work (Fig. 8). Repeat on the other side of the cut.

How are coves or concave cuts made?

Use the small gouge, turned on edge as in Fig. 9, with the bevel at a right angle to the

Beads are turned with the skew chisel, or scraped with the blade flat, while the handle is swung in an arc. For a deep cut, score with the toe, then use the heel, moving from flat to almost vertical

Trimming the side of a cove. The small gouge, turned on edge with the bevel at a right angle to the surface, is rolled gradually into a flat position. The correct cut leaves a glossy finish

surface and the center line of the tool pointing toward the center of the work. As you push the gouge into the stock, roll it gradually into the flat position and lower the handle so that the finishing cut is made with the tool well up on the work and tangent to the cut surface. This forms half of the cut. Reverse the tool to cut the other half. To prevent the gouge from running at the start, it must be held firmly on the tool rest.

Can beads and coves be formed by scraping?

Yes. Use a skew or spear-point for beads; a small round-nose or gouge for coves. Figure 10 illustrates this.

Are any extra precautions necessary in cutting tapers?

It is advisable to work from the large to the small end, cutting with the grain. The work is done with a skew and is similar to turning a cylinder.

How are the ends of the work squared?

With pencil, mark the length. Set the parting tool (Fig. 1) *on edge* on the rest and high on the work, then gradually lower the point into the cylinder, as in Fig. 11, with a short side-to-side motion to cut slightly wider than the tool. A skew chisel, laid flat with the edge at right angle to the work's axis, is then used to scrape the end square.

It is also possible to use a narrow skew chisel. Rest the tool edgewise with the handle low and to one side so that one bevel is at a right angle to the axis of the work (Fig. 12). Slowly raise the handle to drop the point into the work. Make a second cut to the gauge line with the handle still farther to the side. Return to the first position to trim the entire face to line with the toe. Avoid letting the heel of the tool catch in the work.

How is work cut off?

Square the ends as described, leaving enough stock to support the work in the lathe. At low speed, cut off the piece at the live-center end with the toe of the skew, simultaneously encircling the work with the fingers of the right hand to catch it when it drops. Then rotate the piece with the left hand to cut the dead center end off, using the skew in the right hand. Continue until the piece has been severed.

(To be continued)

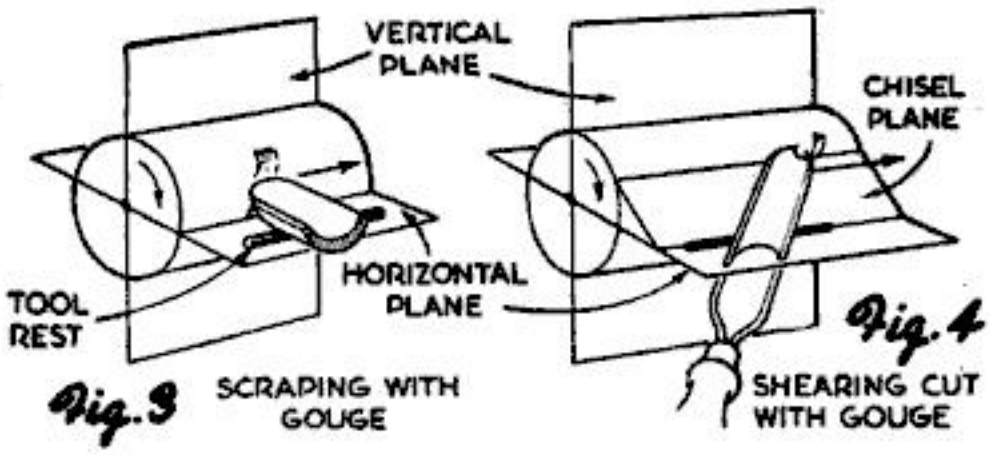


Fig. 3 SCRAPING WITH GOUGE

Fig. 4 SHEARING CUT WITH GOUGE

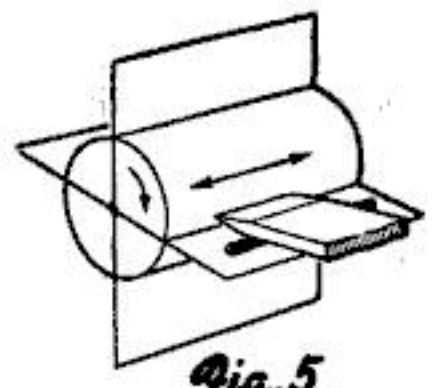


Fig. 5 SCRAPING WITH SKEW

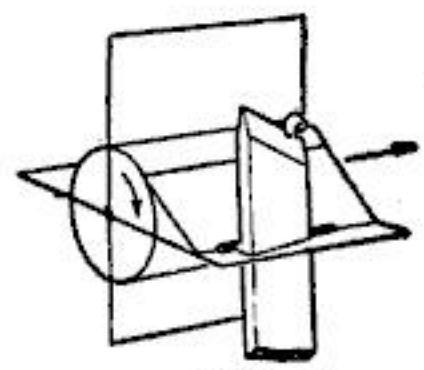


Fig. 6 CUTTING WITH SKEW

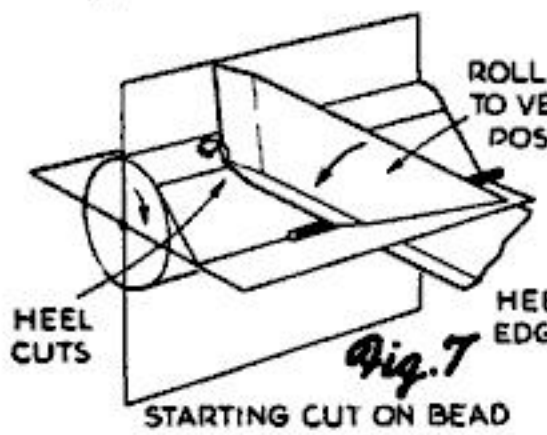


Fig. 7 STARTING CUT ON BEAD

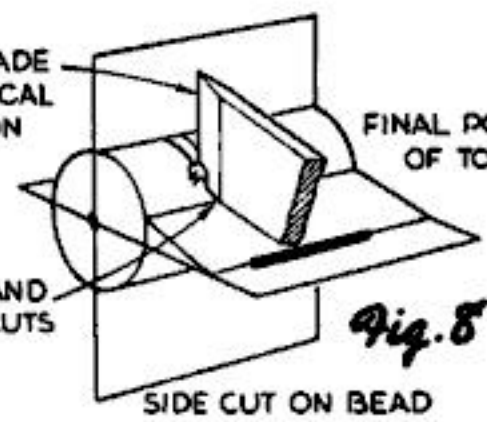


Fig. 8 SIDE CUT ON BEAD

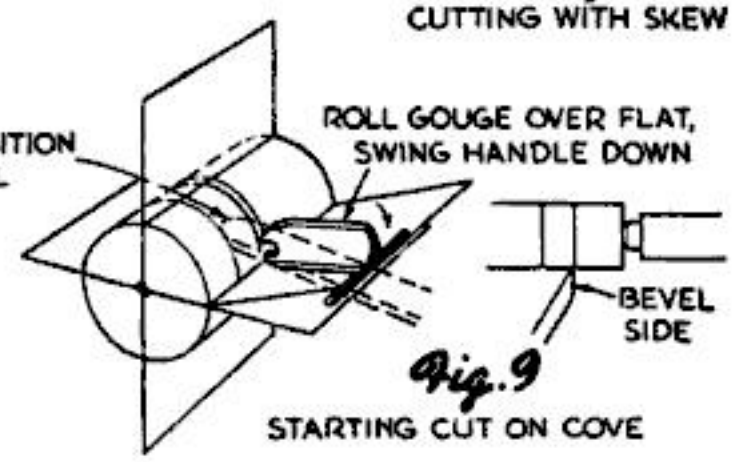


Fig. 9 STARTING CUT ON COVE

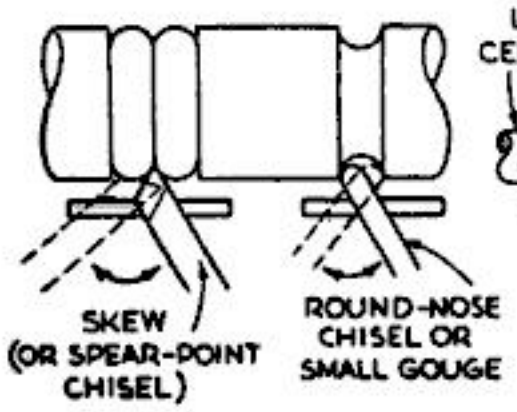


Fig. 10

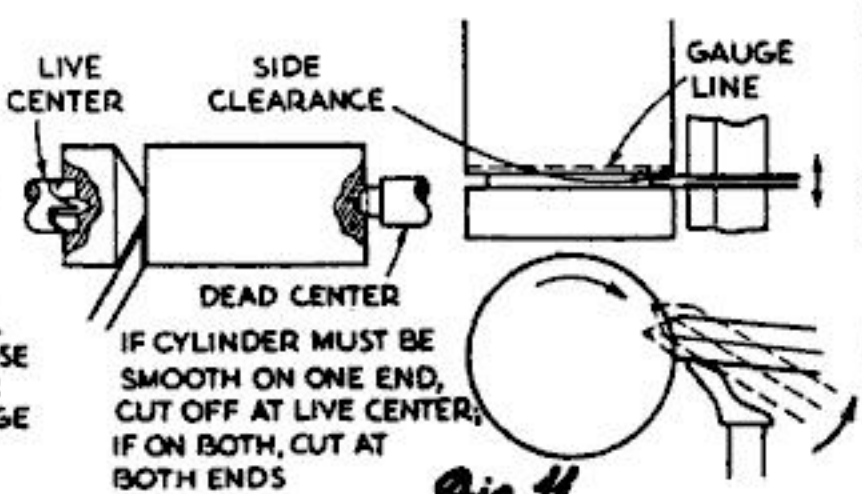


Fig. 11

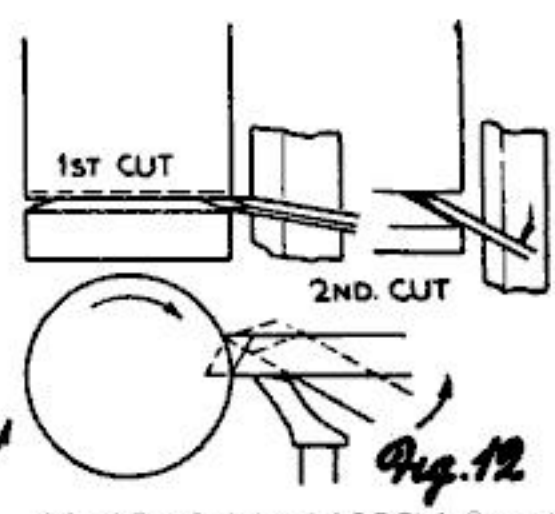


Fig. 12 SQUARING WITH NARROW

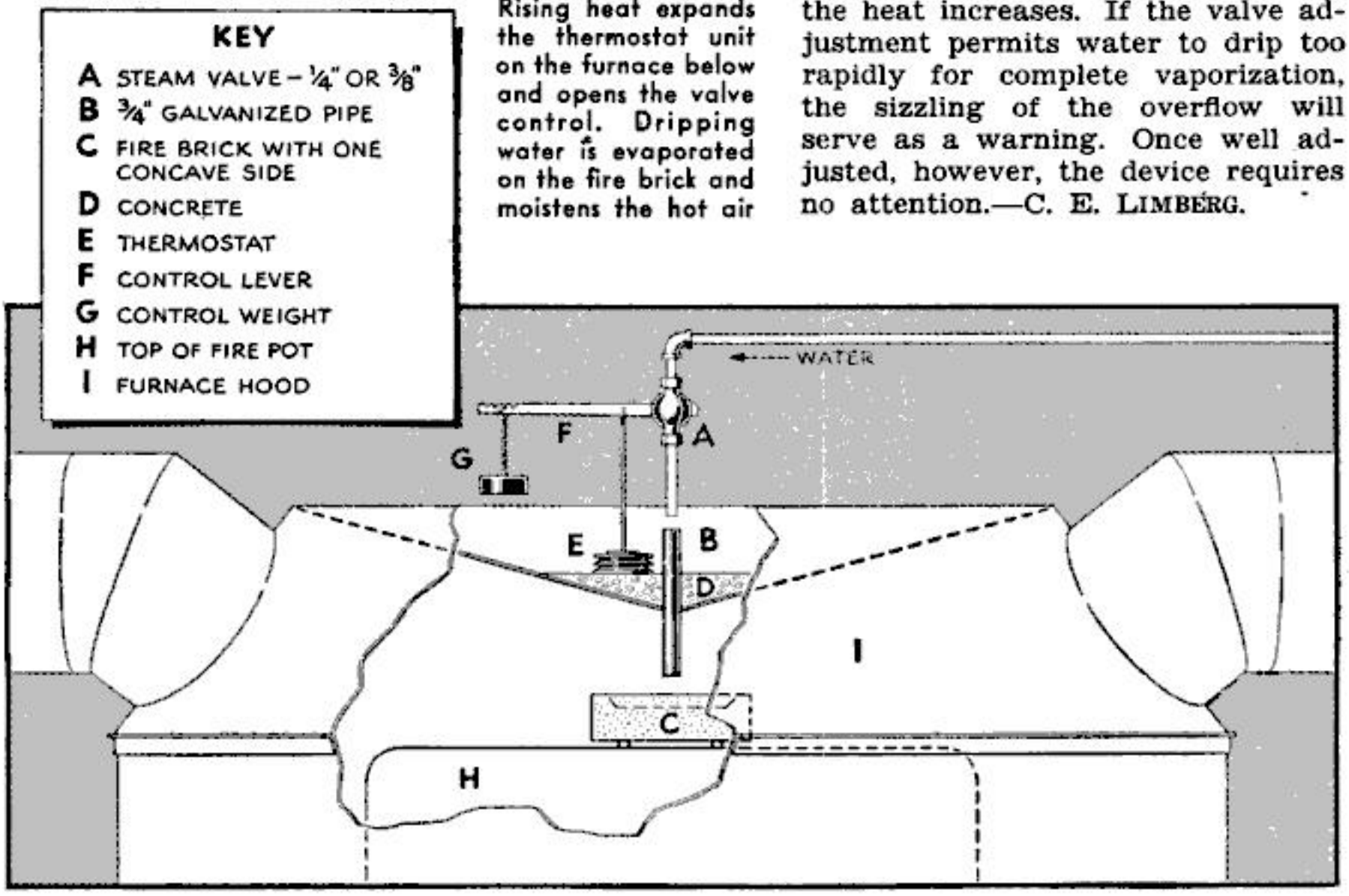
Automatic Humidifier Installed in Hot-Air Furnace System

EXCESSIVE dryness in a house heated by a hot-air furnace can be avoided by the installation of an automatic humidifier on top of the fire pot.

Remove one of the hot air pipes temporarily, and through the opening lay a concave-faced fire brick, with the concave face up, on small stones or pieces of metal to allow circulation between the bottom of the brick and the top of the fire pot. If a fire brick of this type cannot easily be obtained, build a rim of fire clay or Portland cement around an ordinary fire brick.

Insert a 12" length of ¾" galvanized pipe through a hole in the furnace hood directly above the center of the fire brick, and pour 2" or 3" of concrete around it to hold it in place. Next, conduct water through ¼" or ⅜" galvanized pipe or small copper tubing from the house water main or water heater, arranging the opening so that water passing through a high-pressure valve, such as a steam valve, will drip through the ¾" pipe onto the concave face of the fire brick, vaporize, mix with the hot air in the system, and circulate with it through the house.

The valve can be made automatic by connecting it with a thermostat, the unit of which can be obtained from an automobile supply store, a furnace shop, or a discarded automatic heating device. To install, attach a metal or wooden lever to the valve wheel as shown, and suspend a weight on the end to pull the lever down when the thermostat unit is cool and contracted. Expansion will open the valve again when the heat increases. If the valve adjustment permits water to drip too rapidly for complete vaporization, the sizzling of the overflow will serve as a warning. Once well adjusted, however, the device requires no attention.—C. E. LIMBERG.



Old Crêpe-Rubber Soles Turned into Satisfactory Cement

QUICK-DRYING rubber cement for mounting photographic prints and other paper-cementing jobs can be made from old crêpe-rubber soles. Clean the rubber thoroughly with soap and water, let it dry, then wipe with benzine or gasoline. Cut the sole into small pieces and throw these into a jar or bottle containing benzol (use the technical grade) in the proportions of about 1½ oz. rubber to 1 qt. of benzol. Set this aside for a few days.

If you wish a less inflammable cement, substitute 10 oz. of carbon tetrachloride for 10 oz. of benzol. Another good mixture is half benzol (sometimes called benzene) and half ordinary benzine. Plain benzine can be used, but it takes much longer to dissolve the rubber, longer to dry, and does not make quite as smooth a cement. Your shoemaker has old crêpe soles or scraps of new ones, which he will probably give you for the asking.—DAVID SCHUCHMAN.

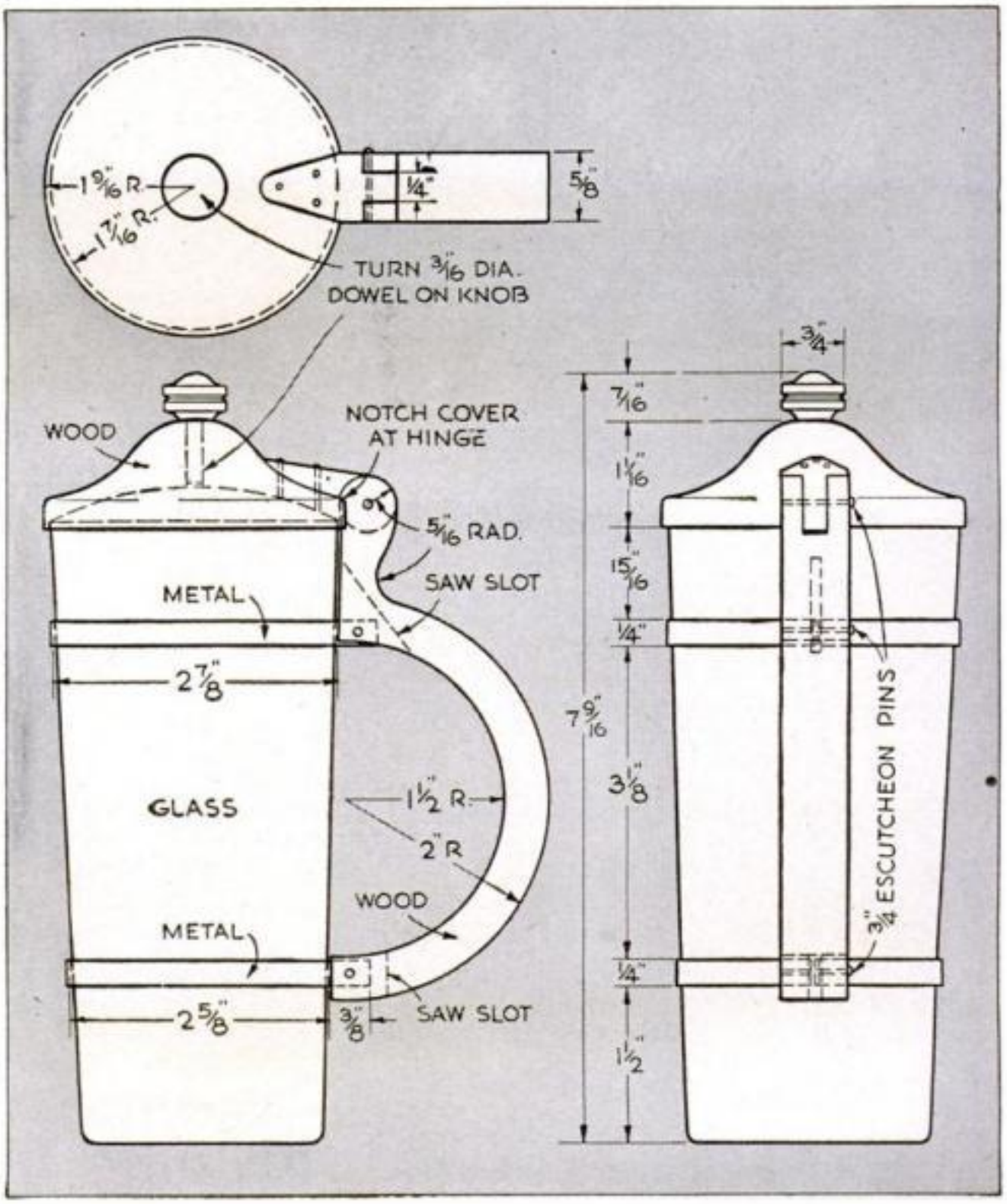
Craftwork for Merrymaking

TWO PROJECTS PREPARED ESPECIALLY FOR POPULAR SCIENCE BY ERNEST R. DEWALT

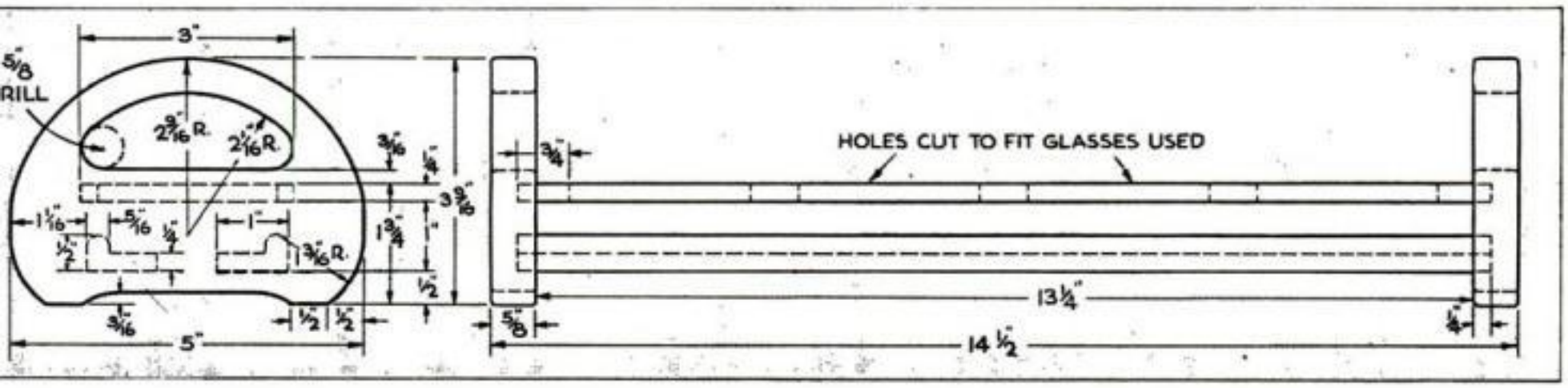
JOLLY-FOURSOME STEIN SET. Tall glasses, obtainable at the five-and-ten, can be converted into a handsome beverage set by the addition of wooden covers and handles. This makes an ideal accessory for the owner of a basement bar, although the glasses are suitable for all-around home service, especially if they are used with the matching tray described on the facing page.

The handles are band-sawed from 5/8" thick maple. It will probably save an appreciable amount of time to cut a cardboard pattern to lay out the work. Turn the maple covers from 1 1/8" stock, mounted on the screw center of the lathe. Make the diameter of the inside rabbet to fit the glasses used without binding. In turning the knobs, leave a 3/16" diameter dowel on each of them to glue into the top of the cover. Saw the hinge flaps to shape and fasten them to the lids with three escutcheon pins each, fitting these into holes that have been pre-drilled and riveting the ends over lightly.

The metal bands may be of thin aluminum, copper, or brass. By a trial fitting, determine the height on the glass at which these will come, and bend them to slightly less than the corresponding diameter. Bend back the two ends of each band for 3/8", slip them into the saw kerfs in the handle, and insert the glass to make certain that the lid will close squarely down on the rim. If the fit is correct, drill through both wood and metal simultaneously for escutcheon pins, and rivet these fast. The handles can be slipped off quickly for washing the glasses.



Ordinary glasses fitted with covers and handles become steins. The tops are easily turned, and the handles band-sawed. The dimensions in the sketch at right should be altered to suit the glassware which is used



Intended for use with the decorative steins, the wooden tray in the drawing above has two shelves, one with holes through which the glasses fit. The space between them should allow the handles to clear

Turned parts are easily finished in the lathe. Three coats of clear lacquer, each rubbed before the next is applied, are suggested for a light-toned effect, or some other appropriate finish may be given. Approximate time (one cover and handle), 3½ hours.

BEVERAGE SERVICE TRAY. Although designed for the set of glasses described above, this tray can be made as a separate project to fit others by altering the size of the holes in the upper shelf. Maple, which was used for the stein covers and handles, is also the suggested material for the tray.

The shelves should be of a length to fit four of the glasses chosen. The lower one consists of two L-shaped moldings, partially formed on the circular saw and then sanded to the shape shown. A circle cutter can be used to make the holes in the top shelf if the piece is not cut to width until these are finished. A scroll saw also will cut them quickly. Rout out the ¼" deep mortises in the two ends before sawing these to shape, in order that the edge of the stock may serve as a guide on the routing table. The mortises can be cut with a chisel if other means are not available. Glue the parts together and clamp fast after checking alignment to see that there is no twist or wind in the assembly. Finish to match the stein handles. Approximate time, 3¾ hours.

• • •

WOODEN tongue depressors, obtainable at trifling cost in any drug store, have many uses in craftwork, such as spreading cement and glue, and stirring small quantities of paint and other mixtures.—M. E. W.

How to Prepare Your Own

Clear varnish or lacquer is applied in a smooth coat to the gummed side of "decal" paper, which can be bought or prepared with gelatin and starch

Designs are painted or printed on the lacquered surface. Water colors, oils, or ink may be used

Clear lacquer seals in the water colors. Be sure no pinholes remain, for the "decal" must be soaked

By VERNON B. CASE

SPECIAL decalcomania designs, or "decals" as they are called, are easy to make for use in decorating furniture, china, trays, holiday windows, and doing a host of things that are difficult by other methods.

The special, coated paper that is required can be purchased at some art stores for about 20 cents for a 25" by 36" sheet, but usually no less than six sheets will be sold. Ask for the so-called "simplex" decalcomania paper rather than the duplex type.

To prepare your own, get several sheets of unsized paper, such as newsprint. Dissolve some dry laundry starch in boiling water in the proportion of about one teaspoonful to a half cup of water. This makes a thick paste when cool. Brush a layer of starch on one side of the paper, let it dry, and repeat with one or two more layers. Sometimes better results are obtained if the paper is first coated with a solution of gelatin. Clear dessert gelatin will do. Soak it in water to soften it, then heat until the gelaatin is dissolved.

For small designs, the gummed side of gummed labels can be coated with starch. The gum, like gelatin, facilitates the transfer of the design.

The first step in making a decal design after the paper is on hand is to cover the starch-coated surface with varnish or lacquer. Ordinary clear brushing lacquer or well-thinned, clear spraying lacquer may be used. The latter generally does not have the

After soaking, the loosened design is transferred to a permanent surface by sliding out the paper

"Decal" Transfers

slightly yellowish cast that brushing lacquer has. Either can be applied with spray or brush. Be sure the lacquer coating does not contain any pinholes.

When the lacquer is thoroughly set, you are ready to apply the design. This can be done in various ways.

1. If you have a printing press, you can print on the lacquered surface with ink in the ordinary way. Let the ink dry thoroughly before attempting to apply the decalcomania.

2. Brushing lacquer of various colors can be used to draw designs and do lettering on the paper.

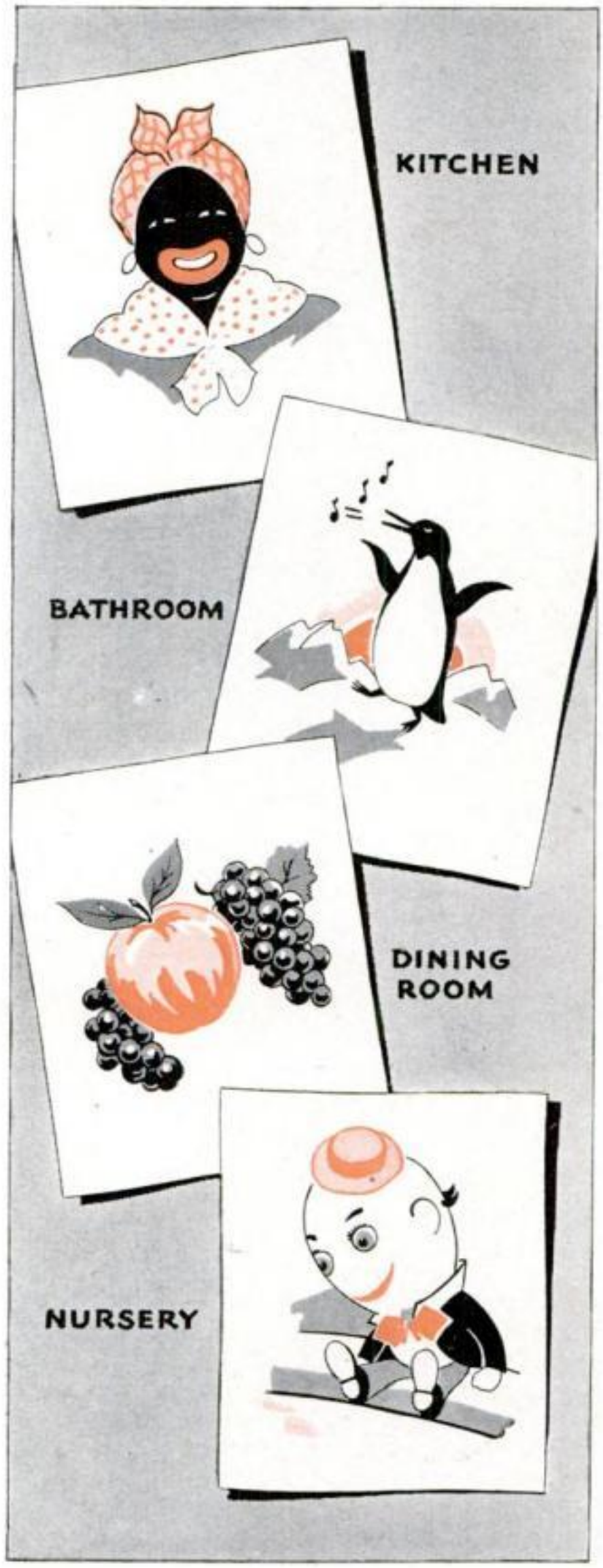
3. The silk-screen stencil process offers unlimited means of producing decal designs.

4. You can use ordinary water colors for painting pictures on the lacquer coating. This is probably the easiest method for the novice. After the water colors are dry, apply a sealing coat of lacquer over them. Be sure this coat is also free of pinholes or other flaws. Later, when you wet the design to transfer it, the lacquer protects the water-soluble pigments.

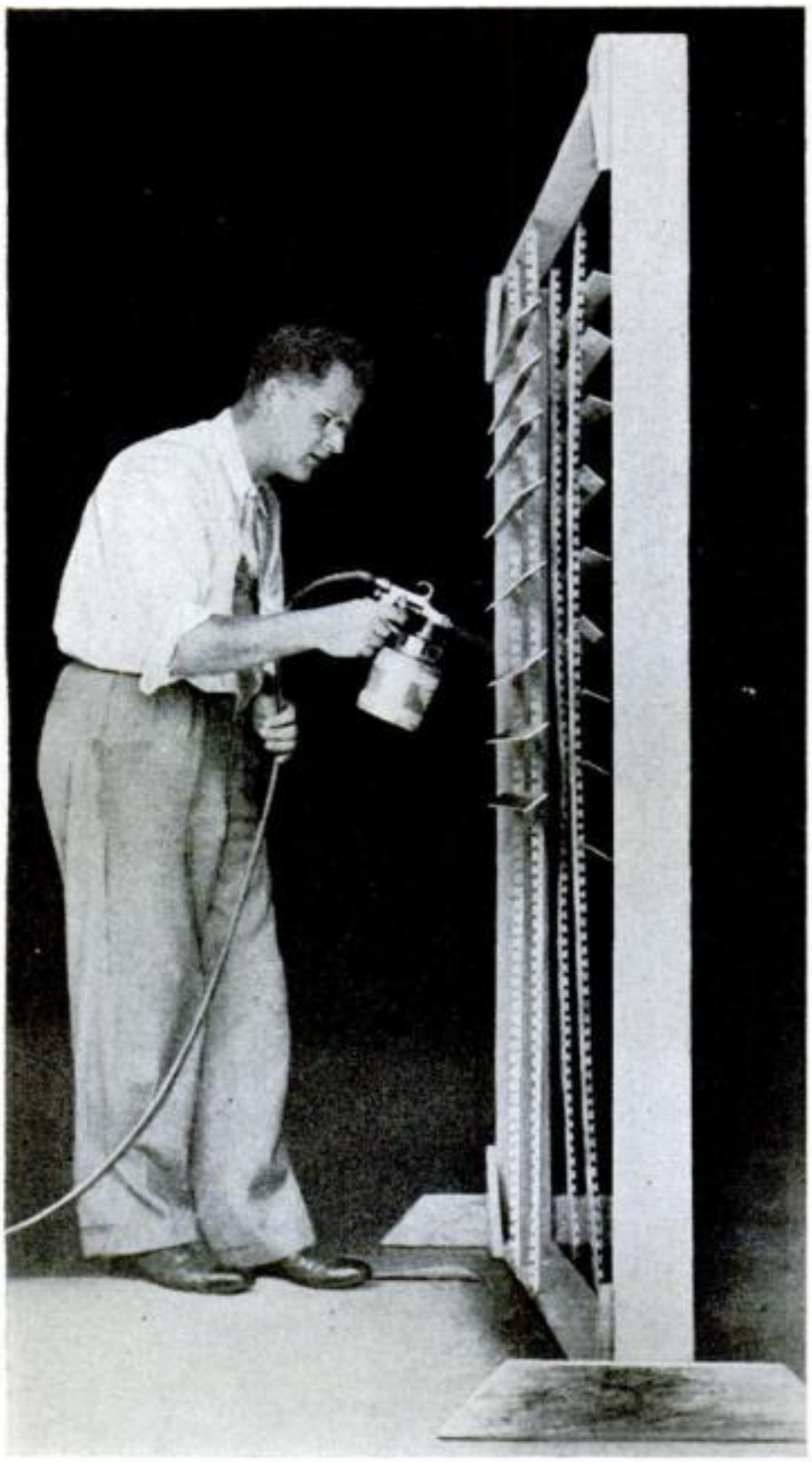
To transfer a decal design to another surface, either trim the paper to form a rectangle as small as the design will permit, or trim around the design in outline, leaving a margin of about ⅛". Then immerse the paper in water to soften the gum coating so the lacquer film will slide off. When you use homemade, starch-coated paper, you may have to continue the soaking for several minutes. Commercial decalcomania paper requires less than a minute.

As soon as the design shows signs of loosening, push the top edge off the paper a fraction of an inch, hold it in contact with the surface on which the transfer is to be placed, and slowly draw the paper from beneath the lacquer film. The gum coating acts as an adhesive, so merely smooth out air bubbles, and your transfer is complete. Air bubbles that cannot be coaxed out by gentle pressure with a damp cloth can be deflated with a pin prick.

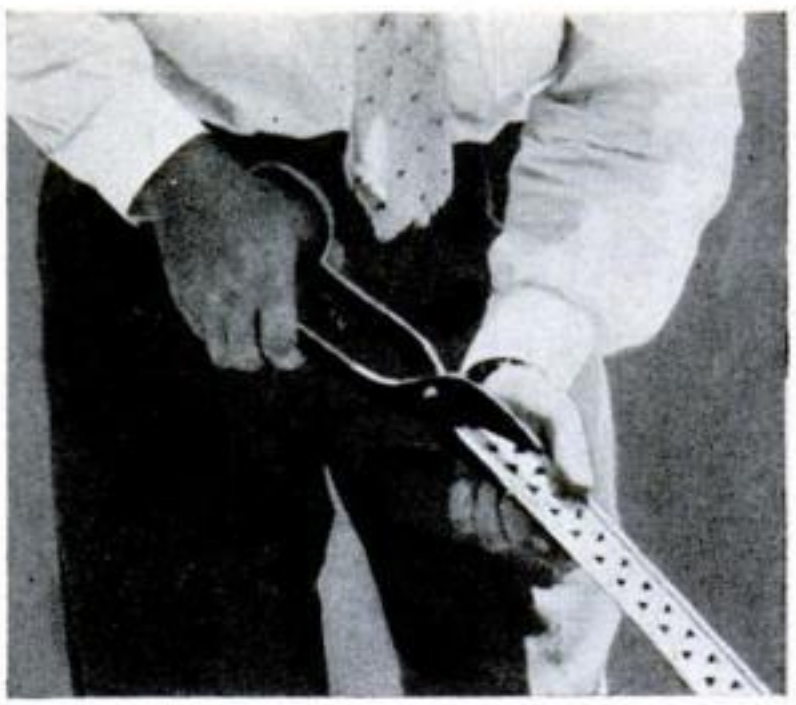
You can vary the procedure somewhat by coating the outer surface of the design with gelatin, letting it dry, and then soaking the transfer to soften both this coating and the one under the lacquer film. Apply the design to the surface with the paper-side out, and strip off the paper. When used this way, the design will be reversed.



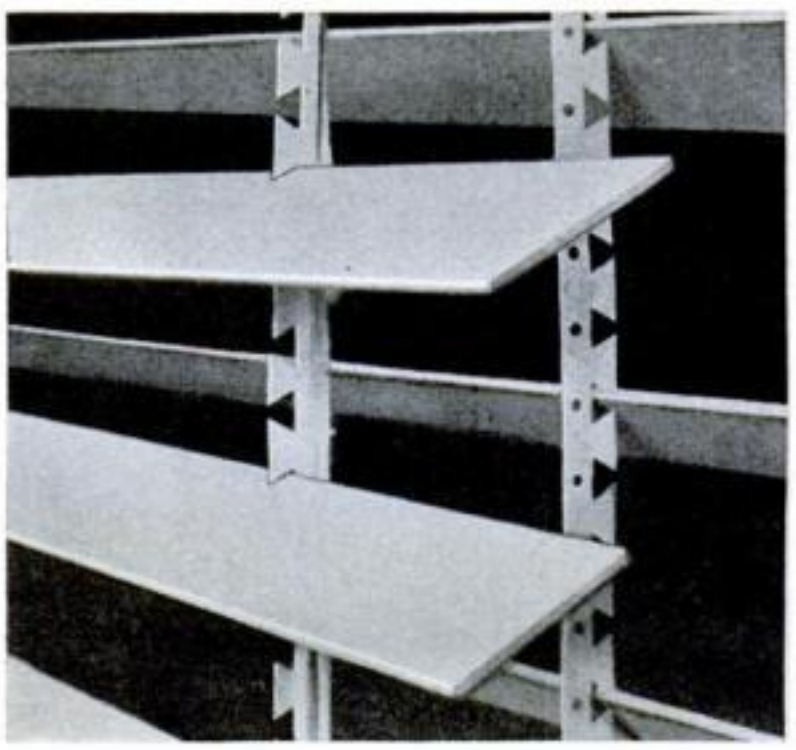
Four designs in smart-looking modern style prepared especially for readers who wish something a little different from stock decalcomania units



Paint can be sprayed on the top of one Venetian-blind slat and the underside of another at one time if they are spaced properly. This speeds the job considerably



With tin shears, the long strips can be cut from galvanized-iron plaster molding. The corner bead (above) has a second side like the one showing, so four strips can be cut from one piece. It is made in 6′ to 12′ lengths



The notches should be opened enough for the slats to be clasped without being loose, and should hold at the spot where the tape comes

Rack Holds Venetian-Blind Slats While They Are Repainted

VENETIAN blinds may be repainted quickly and perfectly by taking them apart and holding the slats in a rack made as shown. If the slats are spaced correctly on both sides of the rack, it is possible to spray in one operation both the underside of a slat on the far side of the rack and the top of a slat on the near side. The worker can then completely finish both sides by working first on one side of the rack, then repeating the operation on the other side.

The notched strips into which the slats are slipped are cut from a strip of metal plaster molding obtained from a building-supply house. This molding is lightweight galvanized iron, which is easily cut lengthwise into four strips. Care should be taken to see that the cut opens the perforations sufficiently so that a slat from the Venetian blind will slide in without being too loose. The shape of these perforations is such that the slat is automatically held in the correct position for spraying.

The four metal strips are nailed to a wooden frame, two on one side, and two on the other, and the metal bent so that the openings will take the slats. Space the strips so that the notches will catch each slat where the tape comes on the blind. Even if the metal leaves a slight mark on the wood, the defect will be hidden when the blind is reassembled. Put half of the slats on one side and half of them on the other side of the rack.—MAURICE B. DENNISON.

Compact Home Workshop Built in End of Attached Garage

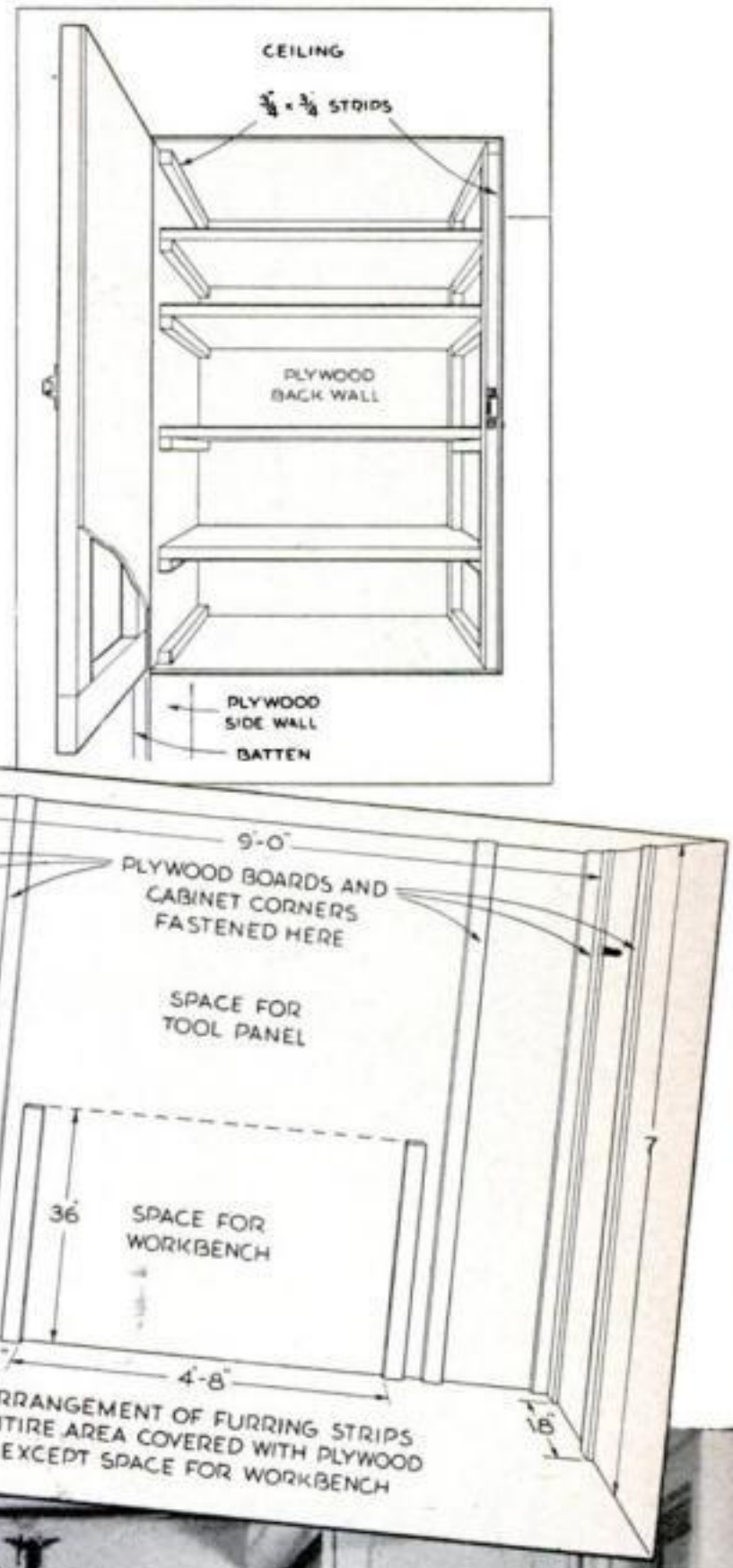
FINDING a place for the home workshop is often a problem in small, modern homes, especially when the basement contains a finished playroom as well as the usual furnace and laundry equipment. One solution, if there is an attached garage, is to use the end of the garage as a shop.

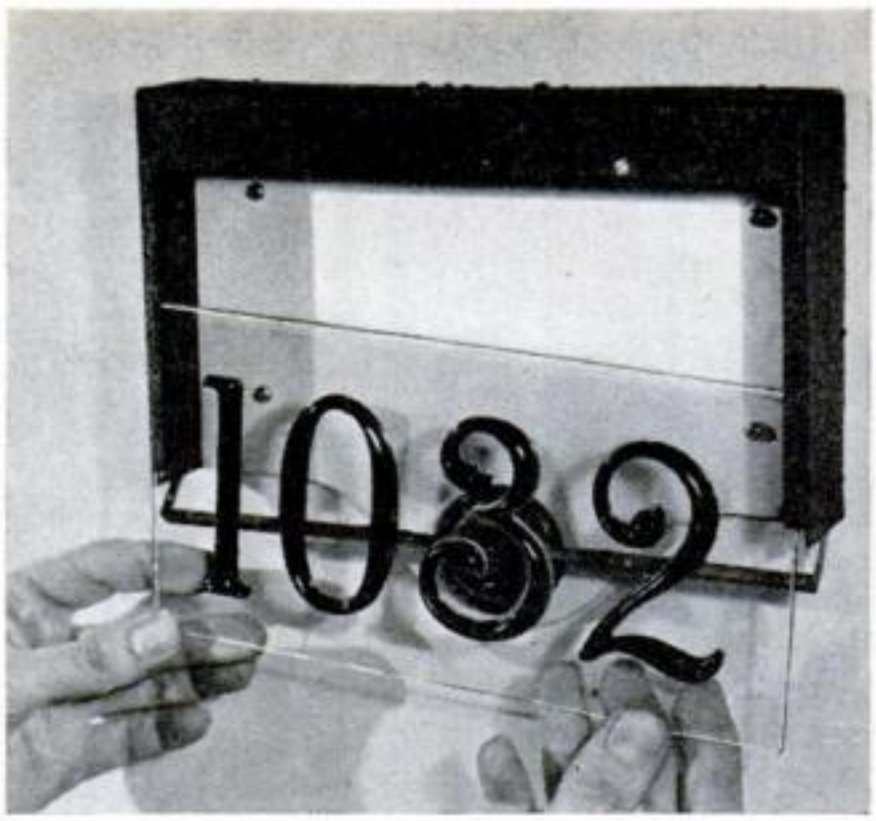
How this may be done is shown in the accompanying illustrations of the shop of Joseph D. and George W. Gross, of Elmhurst, N. Y. The garage is 9′ wide and 18′ 8″ long. The overall length of their car is 15′ 6″, and the depth of the shop is 18½″, leaving about 20″ leeway. They find it no trouble to move the car back a few feet when they want to work in the shop. Blocks placed on the floor stop the car from rolling too far forward.

The first step in constructing the shop was to line the concrete wall with furring strips attached with the aid of lead plugs. These studs were then covered all around with ¼″ plywood except in back of the workbench. The tool panel was reënforced with ¾″ wood to form a solid backing for the tool brackets. The separation between the top and bottom cabinets allows space for working on long boards.

The cabinets are constructed of plywood, and ¾″ by ¾″ strips are used for the frame and shelf rests. Flathead screws countersunk in the plywood attach it to the strips. The finished plywood walls serve as two sides for each cabinet, so it is necessary to construct only one side, a top, a bottom, and a door.

Note that the overhead lamp and shade slide along a curtain rod. The drawer under the workbench rolls on casters and holds scraps of wood.





Making it easy to clean the reflector and glass, or to change the bulbs in this illuminated unit for house numbers, the front panel is removable

Illuminated House Number

By WALTER E. BURTON

BY THE method shown in the accompanying wiring diagram, a doorbell circuit can be used to operate a house-number and utility light for practically nothing. One or two lamps are connected across the doorbell button. These burn at a brilliancy lower than normal, consuming almost no current, but give enough light to make them useful. Lamp life is very long; a year or more of 24-hour-a-day burning can be expected. The current taken by the lamps is always flowing through the bell, so a low-current lamp is necessary.

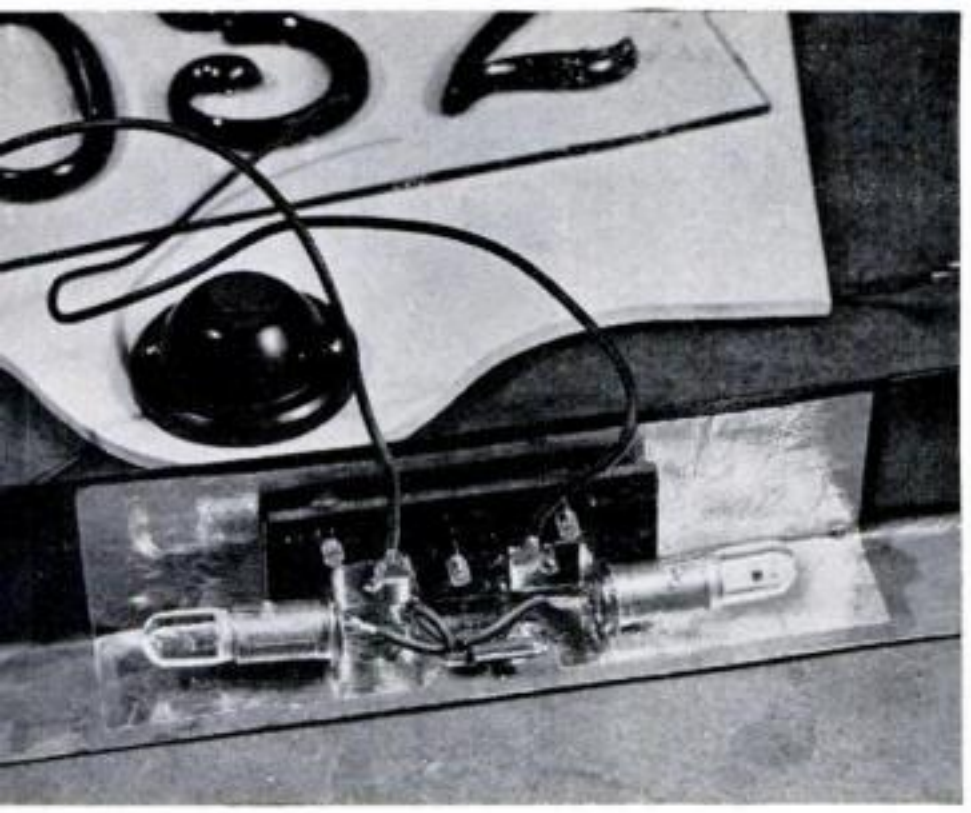
Two satisfactory arrangements have been worked out. One is to connect two so-called radio-panel lamps, No. 40 or 47, in series across the doorbell-button terminals. These are 6- to 8-volt lamps normally drawing 0.15 ampere. The difference is that No. 40 has a miniature screw base and No. 47 a bayonet base. The other arrangement makes use of a single No. 1481, 14-volt, 0.15-ampere miniature screw-base lamp across the button.

Some transformers give voltages higher than the 8 to 10 volts usually found, particularly those used with chime signals. In such cases, lamps designed for higher voltages must be used.

There are various ways of utilizing doorbell-operated lamps. If there is no need to light a house number, the lamp or lamps can be housed in a small reflector so that light will be thrown on a keyhole or other place where it is useful.

One of a variety of possible designs for illuminated house numbers is illustrated. Dimensions will vary, for house numerals are made in so many different sizes, and house numbers also may contain anywhere from one to four, or even five or six, figures. The four-numeral lighted unit pictured here is 1½" by 5½" by 9¼" outside, and the frame around the glass is ¼" wide. You will note that this leaves just enough margin of light around the four figures chosen to set them off and make them easily readable at a glance.

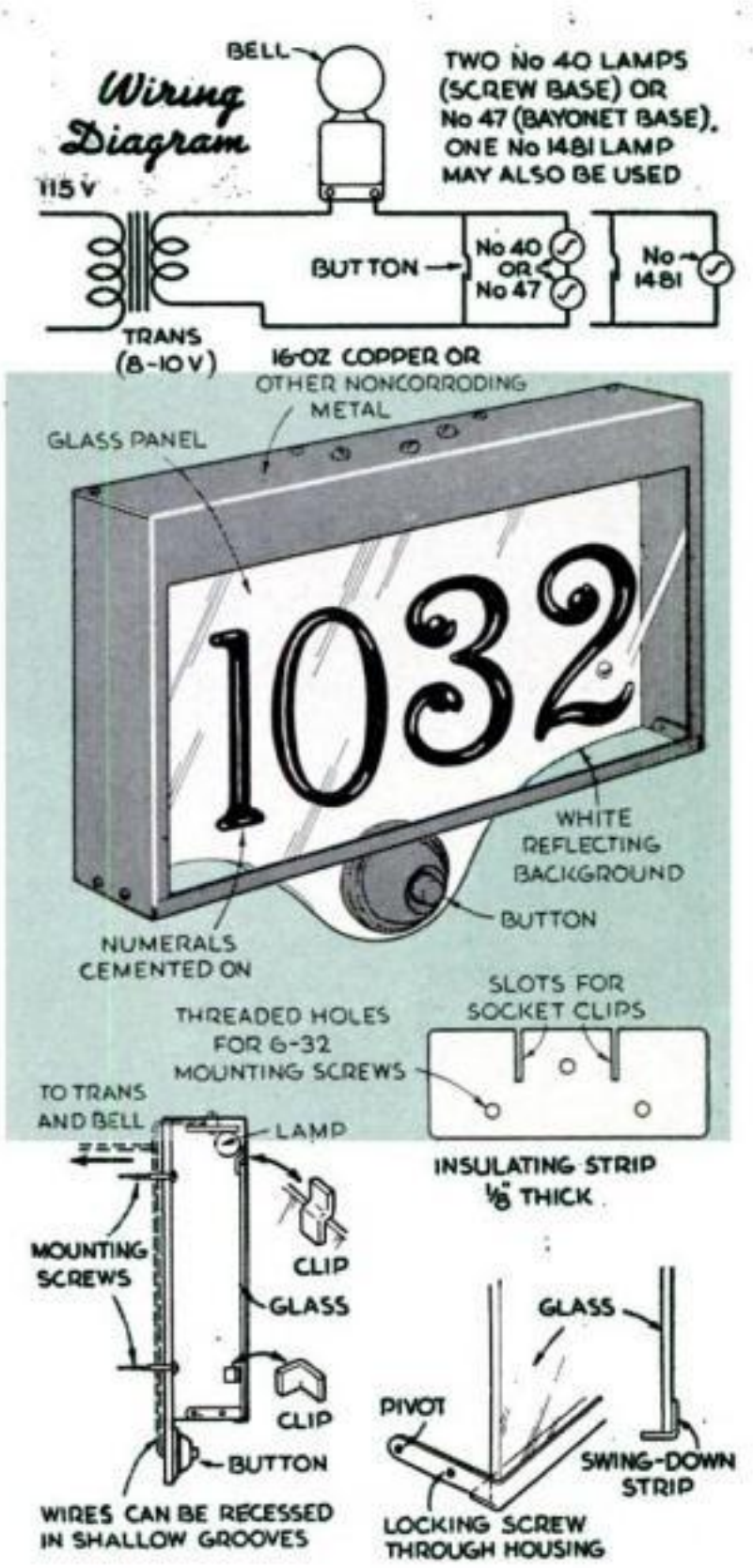
The lamps are housed in an attractive hood made of metal, and the light falls on a white panel, preferably consisting of a piece of white porcelain-enameled iron. Almost any piece of metal or wood painted white, or anything else that reflects light and is easy to clean, will serve satisfactorily. Placed in front of this white area are the opaque numerals, which are thus seen



Two small lamps are mounted in the upper part of the housing. Tin foil is fastened to the metal back of them with lacquer to serve as a reflector

clearly in silhouette. Plastic or metal numbers, which you can make or buy, are fastened on a sheet of glass with Canada balsam, household cellulose cement, or similar adhesive. The glass is mounted 1½" or so in front of the white panel, and held by a swing-down strip which, when closed, can be locked in place by two small bolts passing through holes in the housing and turned-back ends of the strip. If the numerals used have nail holes in them, these should be closed with solder or plastic composition wood.

If the unit is placed at one side of the doorway, light spilling from its bottom will be useful for illuminating porch or steps.



ELECTROPLATING, PART 8 [ELECTRICAL]

When the surface of degreased and chemically cleaned work appears tarnished or coated with an oxide film, it should be treated in a pickling solution to avoid peeling of the plating.

Iron or steel. Either (a) 8 oz. of sulphuric acid to 1 gal. of water, or (b) equal parts of muriatic acid and water. Dip for one minute or less, and rinse immediately in hot water.

Copper, brass, or bronze. Scaling dip: stir with a glass towel rod while adding 68 oz. of sulphuric acid, 13 oz. of nitric acid, and 1 oz. of hydrochloric acid, in the order listed, to ½ gal. of water. Brightening dip: stir while adding 71 oz. of sulphuric acid, 11 oz. of nitric acid, and 1 oz. of hydrochloric acid, in that order, to ½ gal. of water. Use both dips, the scaling dip first. *Avoid breathing fumes.*

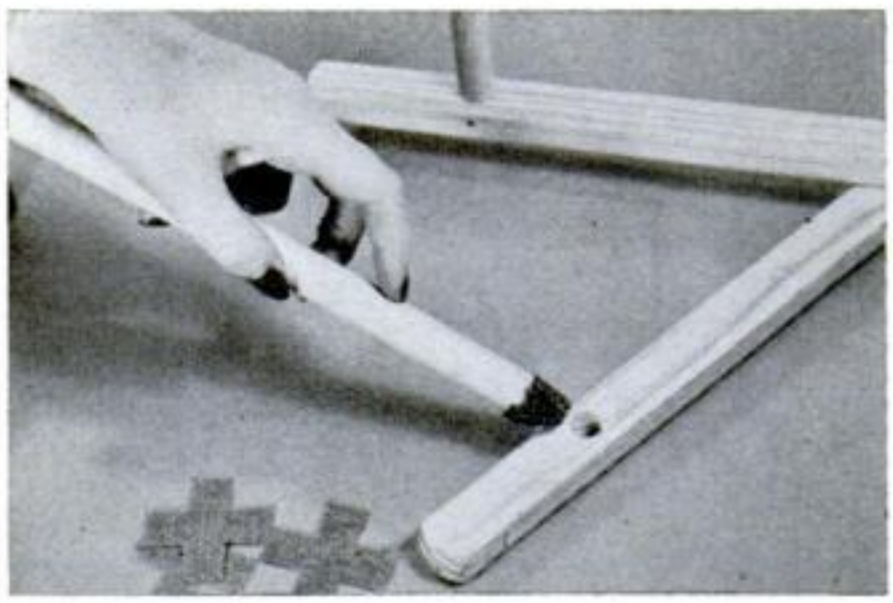
Always add acids to water, not the reverse, use stone containers, and keep the solution cool. Handle the work with a bent wire.

Electric pickling. In a 20-percent solution of sodium chloride (common salt), with brass, copper, or lead cathodes and the work as an anode, follow the procedure for electric cleaning (see Electroplating, Part 7).

POPULAR SCIENCE MONTHLY SHOP DATA FILE

IDEAS for HOME OWNERS

FOR COVERING SMALL SURFACE NICKS on furniture or imparting a new finish when polish and wax will no longer brighten old pieces, a synthetic resin sealer and primer will be found helpful. Applied with a saturated rag over the old finish, it will dry in ordinary room temperature in about four hours, providing a hard surface which is resistant to water and alcohol. Old wax, however, must first be removed, and the sealer cannot be used over lacquered surfaces.

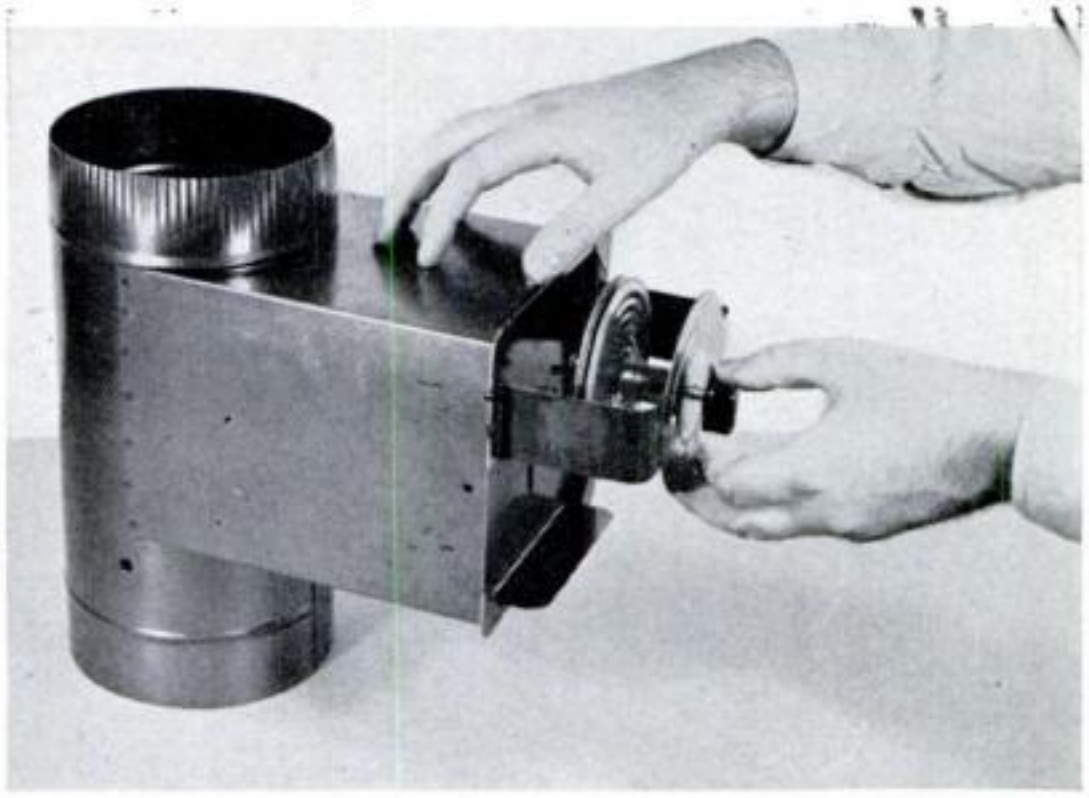


LOOSE CHAIR RUNGS can be repaired quickly with a specially treated fabric cross on sale in small packages. The "joint" is immersed in water for half a minute to moisten an adhesive in the cloth, then centered over the end of the chair rung, and the corners pressed down. The rung is pushed firmly into place, and any protruding bits of fabric are cut away with a razor blade. The joints will adhere to other materials than wood, and will be found useful in mending such diverse things as fishing poles, umbrella handles and ferrules, carpet-sweeper handles, baby carriages, and kitchen knives.

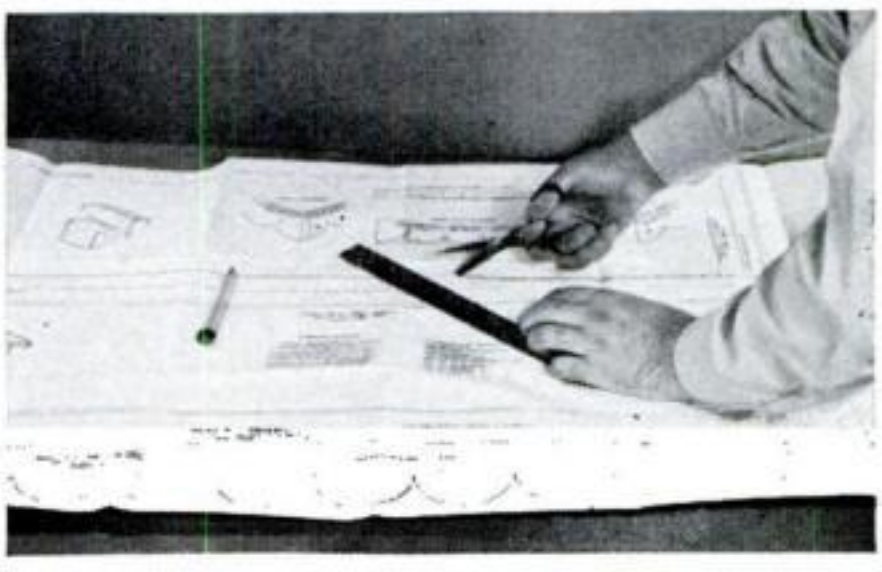
AIR IS FILTERED of ragweed pollen for the relief of sufferers from hay fever in a manner similar to that employed in dust-free air conditioning. The filter unit, a mass of closely packed spun glass in a cardboard frame, is contained in a metal cabinet with extension panels which fit ordinary windows. The conditioner and its installation are shown below and at right.

FURNITURE "SKATES," used in pairs and slipped under heavy articles, are a convenience in changing the arrangements of rooms or moving refrigerators and packed trunks and boxes. Two dollies are connected rigidly so that neither can come out from under the load, even on a rough floor, when the weight shifts from one to the other. They have padded shoulders of felt on which the furniture rests, and are equipped with rubber casters to avoid damage to floors. The skates are bolted to an oak strip. The connecting link is of the expansion type, with a maximum width of 30". Once mounted, a load can be pushed by one man.

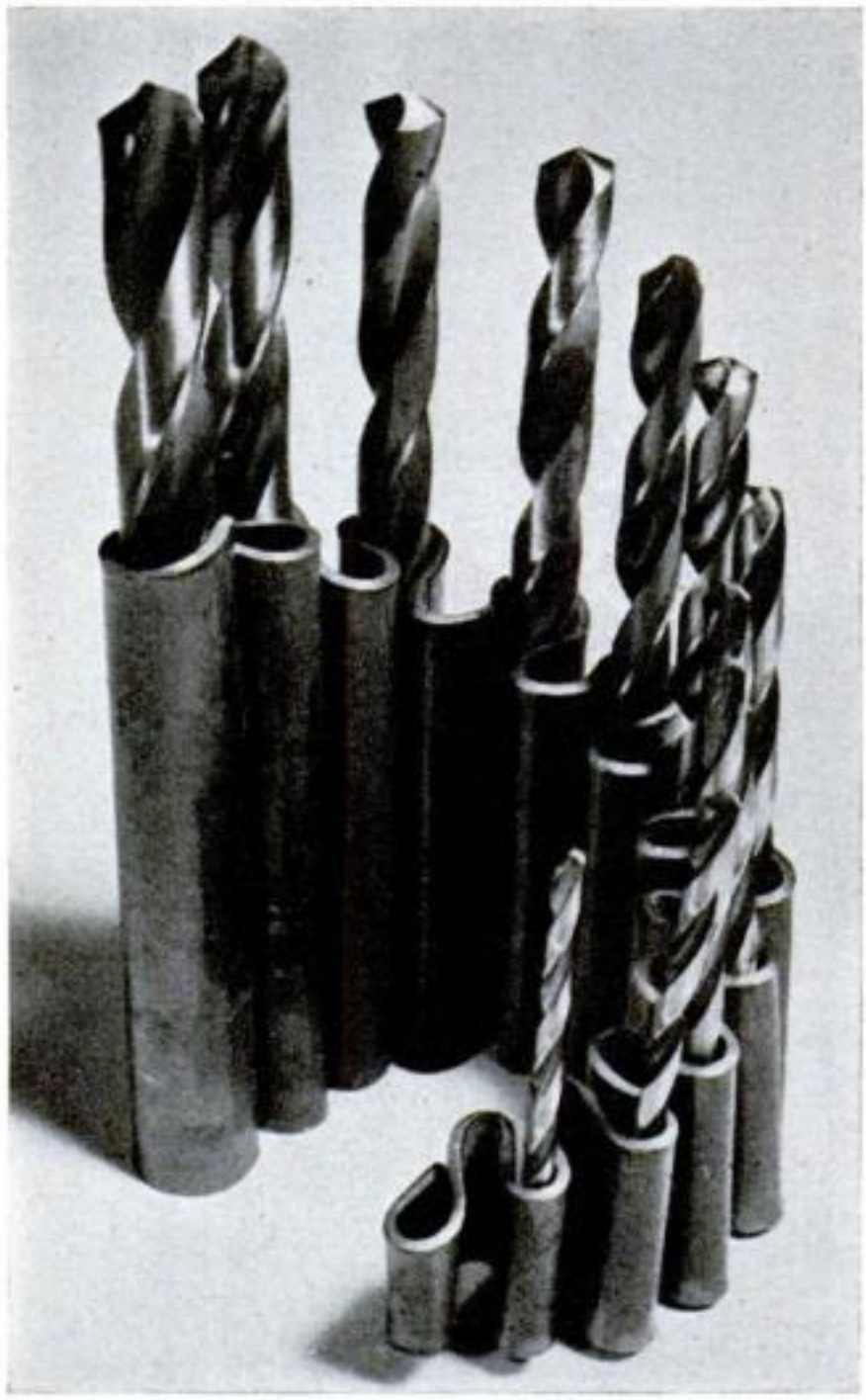
THERMOSTATIC CONTROL for heating stoves, in climates or on farms where oil burners and furnaces are not in general use, is possible with a new type of regulator which operates the draft in the stove chimney. The thermostat is mounted on the stovepipe itself, where its mechanism is affected by the circulation of air in the room, and will open or close the draft at a change in temperature of about 2 deg. It will help prevent over- and underheating and frequent, annoying manual adjustments. As a result of the accurate regulation of the draft, fuel is saved.



PAPER PATTERNS FOR FURNITURE are available for use like dress patterns. They are laid out on wood and traced, and the wood is sawed and assembled. Only ordinary hand tools are needed. The maker at present supplies a total of 29 patterns, covering a wide range of homemade furniture and household articles, such as window boxes, bookshelves, garden furniture, and dog houses, together with detailed instructions on the type of wood most suitable, its thickness, the size of nails and screws to be used, and other hardware information.



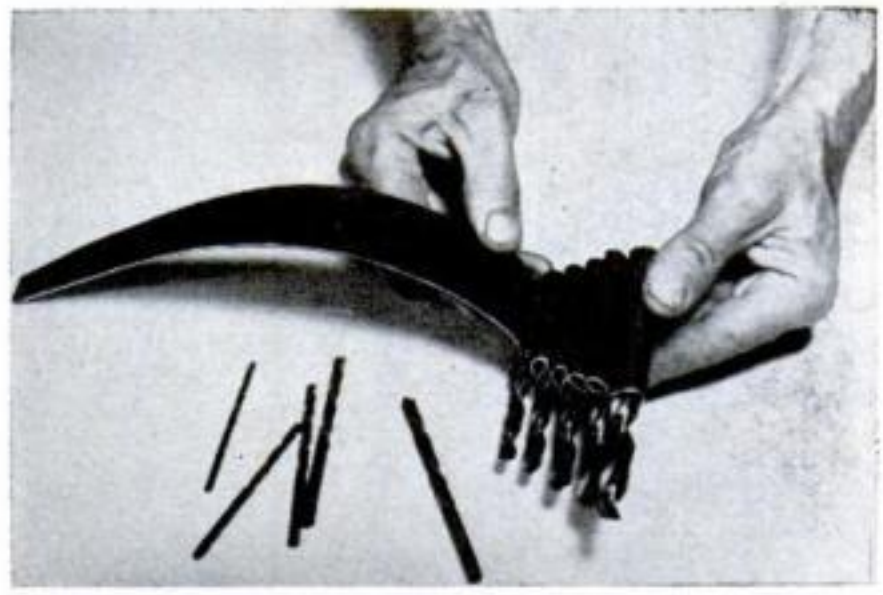
Drill Holder with Large Capacity Bent from Strip of Lead



Shaped from a tapering strip of lead, the drill holder above can be fashioned by hand, being bent to form directly over the bits as shown at right

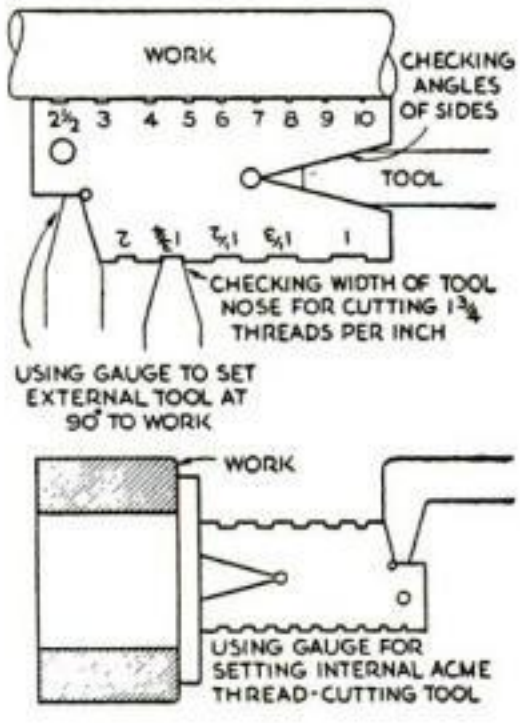
MADE in a jiffy, this handy rack holds a large number of drills in compact form, and is heavy enough not to be upset easily. A tapering strip of sheet lead is used, and all the bending can be done by hand directly over the drills themselves, although a pair of round-nose pliers may be found a convenience for making the smaller bends.

The holder illustrated was made from a sheet of lead about 20″ long and tapering from 3″ at one end to 1″ at the other. As constructed, it has ample room for a dozen or more drills, although the capacity can be increased by bringing the sides of both front and rear loops closer together so that the bits may be held in a double row. A holder made in the form of a hollow triangle or circle is especially stable. Joining the ends with a lead-burning outfit will make it still more rigid.—B. N.



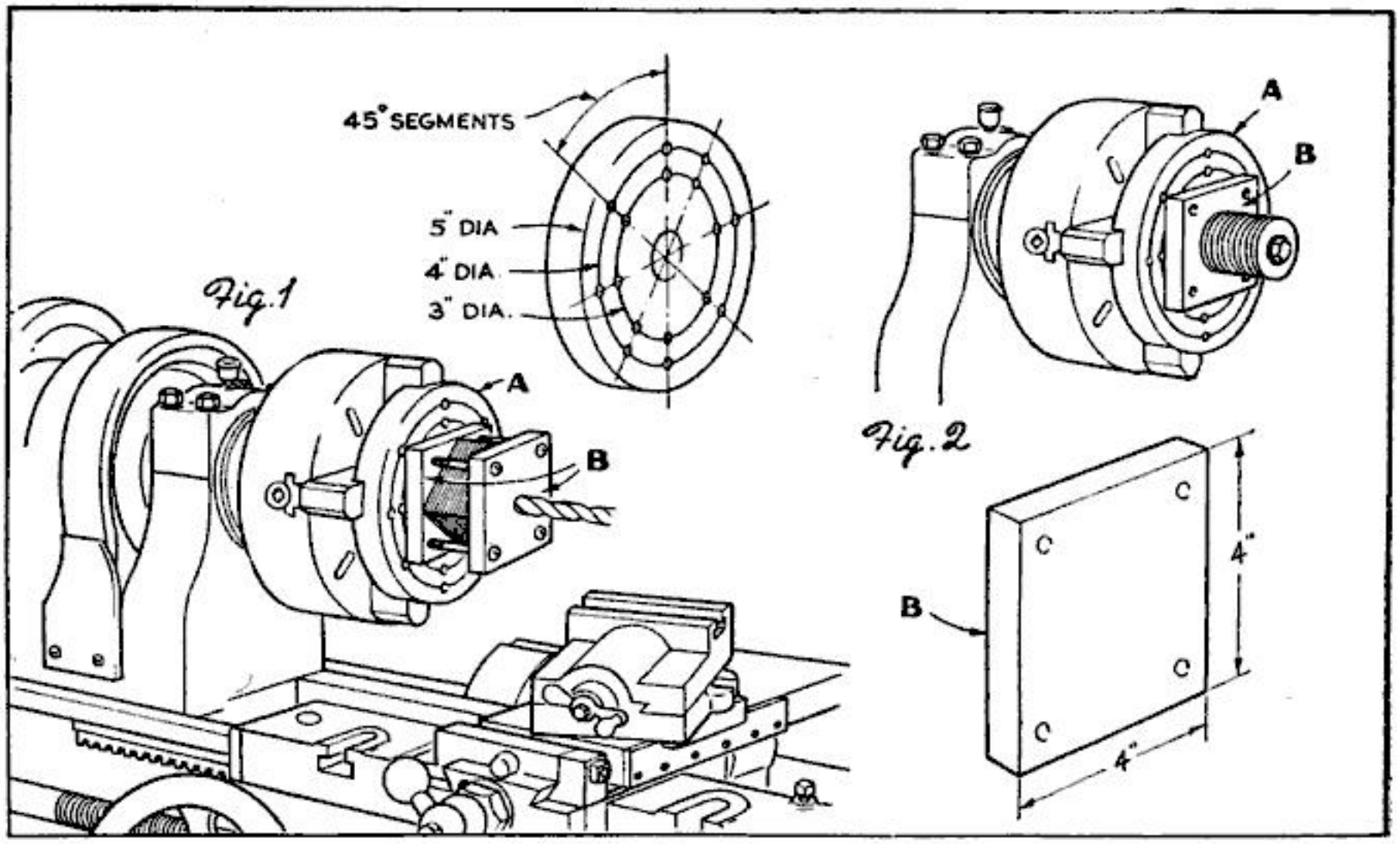
ACME THREAD GAUGE

[*LATHE WORK—25*]



Grind the Acme-thread bit on a machine if possible, checking it during the process with the Acme thread gauge. The 29-deg. V-notch at the end of the gauge is used for testing the angular sides of the tool. Use the shallow notches for checking the width of the cutting edge at the nose. The figure opposite each notch indicates the number of threads per inch for which the width is correct. Set the tool at exactly 90 deg. with the work, using the gauge as shown. The cutting edge is, of course, set precisely on the center line.

POPULAR SCIENCE MONTHLY SHOP DATA FILE



How to Machine Special Washers Accurately in a Lathe

SPECIAL washers of fiber, brass, iron, and other ferrous and nonferrous material can be made quickly and inexpensively in the lathe. Prepare a faceplate, marked *A* in the drawing, 5" in diameter, and scribe on it eight radial lines 45-deg. apart. Center-punch each of these lines 1½" and 2" from the center of the plate; then drill and tap each location for a 3/16" machine thread. Drill a 1" hole in the center of the plate.

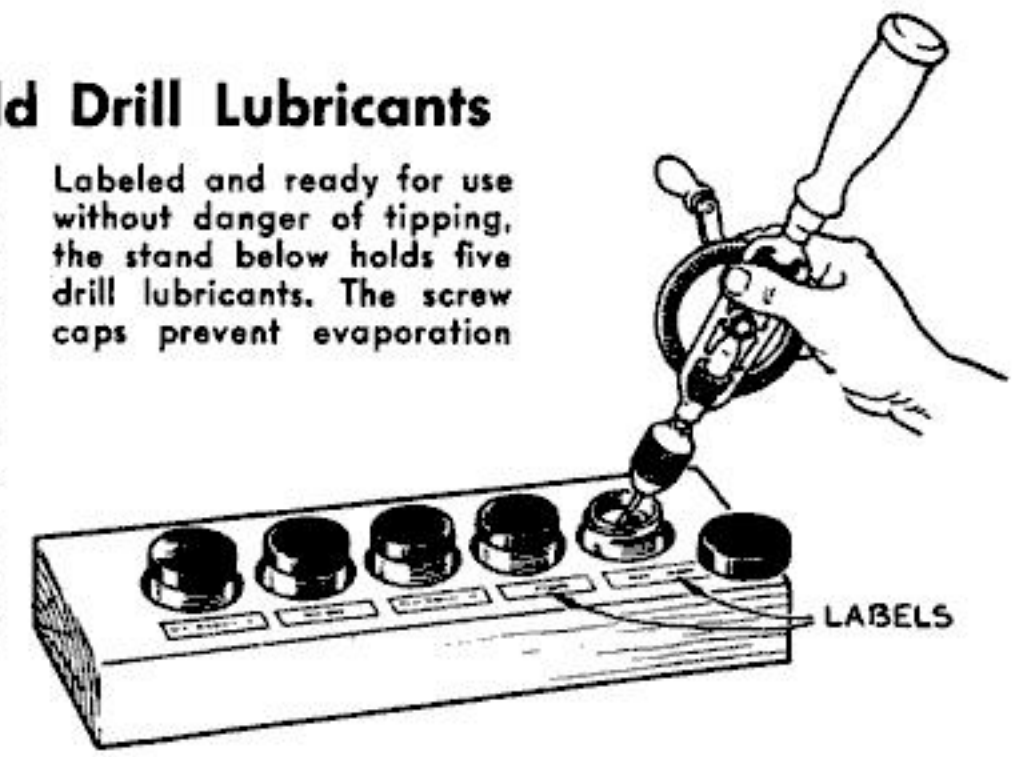
The use of the faceplate can best be illustrated by taking a specific washer, say 1¼" outside diameter, ⅜" inside diameter, and 1/16" thick. Suppose it is made of brass, and the available stock is square scrap material of the correct thickness. Twenty-five washers are required.

Make two wooden blocks *B*, 4" by 4", and drill them on diagonal lines at the corners 1½" from the center. Stack the squares and place them between the blocks. Insert 3/16" roundhead screws and attach the assembly to the faceplate as in Fig. 1. With a ⅜" drill in the tailstock, drill a hole through the assembly. Then insert a bolt in the hole and tighten it with a nut behind the faceplate. Remove the screws, hack-saw the square corners from the outside block and from the stack of brass squares, and then turn the outside block and brass pieces to the required diameter, as shown in Fig. 2.

A set of wooden blocks must be made for each set of washers machined. If the inside diameter of the washers is larger than ⅞", the hole in the faceplate should be more than 1", and additional holes must be drilled and tapped in the faceplate for the 3/16" roundhead screws.—WILLIAM J. HARGEST.

Small Jars in Stand Hold Drill Lubricants

SMALL amounts of the various drill lubricants, such as lard oil, kerosene, turpentine, and soap mixtures, that are needed for drilling certain kinds of metal, can be kept ready for use in a set of small cosmetic jars. Cap the jars to prevent the lubricants from evaporating or otherwise becoming unfit for use. A stand can be made by drilling in a block of wood a series of holes to fit the jars, and gummed labels can be attached and lettered for ready identification.—J. M.



Labeled and ready for use without danger of tipping, the stand below holds five drill lubricants. The screw caps prevent evaporation

MASKING IN SPRAY PAINTING, PART 1 [*PAINTING*]

Masks of adhesive paper or cloth tape will protect areas not to be covered when a spray gun is used for painting. The tape comes in a number of widths, but for the ordinary shop, ½" to 1" is most useful. On small areas, such as chromium or stainless-steel automobile trim, use the tape alone. If the tape is wider than the trim, stick down one edge, then the other, and finally press down the middle. On large areas, use pieces of paper held in position with tape. Half the width of the tape overlaps the paper, and the outer edge marks the boundary.

Crinkled paper tape can be used for fairly sharp curves on flat surfaces. While pressing it into place, stretch the outer edge to form a convex arc, and let folds form at the opposite edge if necessary. When using a paper mask, lay a strip of tape to mark the curve; then use a second strip, overlapping the first, to hold the paper down. Concave curves, if broad, also can be masked.

In removing tape, be careful not to tear the lacquer coat. Be sure the lacquer is dry. If it has been applied heavily, it may be of help to score the film along the edge with a knife.

POPULAR SCIENCE MON

MASKING IN SPRAY PAINTING, PART 2 [PAINTING]

Paper masking tape can be cut to odd shapes for intricate masking jobs, but sometimes it is handier to use ordinary paper stuck in position with rubber or latex cement to mask an irregularly shaped area or a silhouette design. Let the cement set for a half hour or so, then spray several light coats, being careful not to wet the mask enough to dissolve the cement.

A masking compound, available for protecting areas such as windows of an automobile or parts of two-tone color jobs, is brushed on the surface; and after the finish has been sprayed and allowed to dry, the compound and any adhering lacquer or enamel are washed off with a sponge or brush and water.

Cleansing powder applied heavily to glass will prevent lacquer or enamel from sticking.

For rough lettering, striping, and so forth, a wax crayon can be used. Spray the finish as usual, using light coats. Lacquer and other paints won't dry over wax, and can be washed away with gasoline or benzine when the rest of the finish is thoroughly dry.

POPULAR SCIENCE MONTHLY SHOP DATA FILE

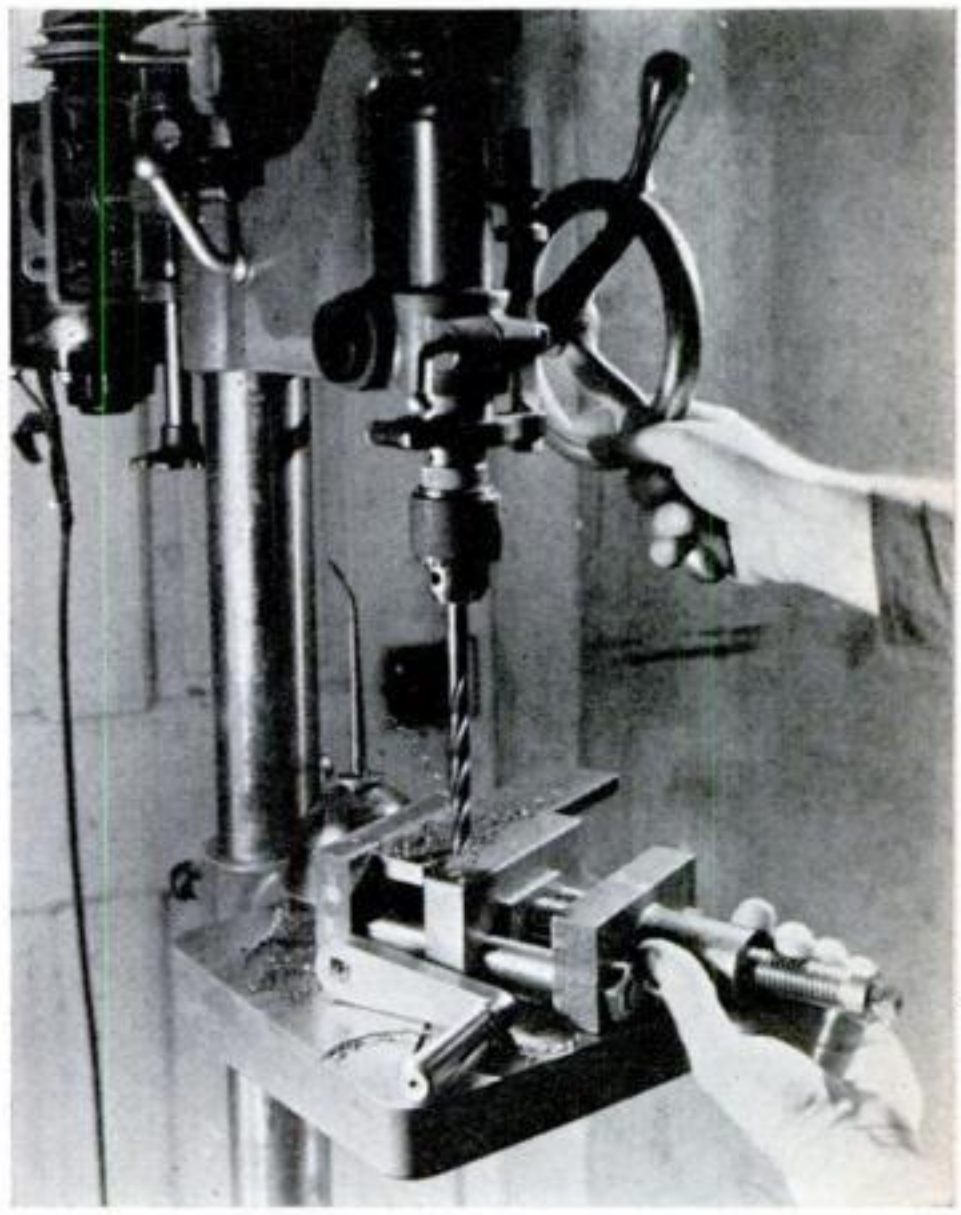
Heavy-Duty Vise for Drill Press Built from Scrap Steel

FOR holding fairly large work or for heavy drilling, a strong vise may be built from short ends of cold-rolled steel and other waste stock as illustrated. The slide rods and vise screw are turned from ⅞" rod, and the slide-rod threads are cut on the lathe to insure accuracy. The two jaws are 1" by 2½" by 4¾". They can be mounted in a four-jaw chuck and the ends turned smooth and square, as this will save a lot of filing and insure the finished vise being square so that it may be used on its side when necessary.

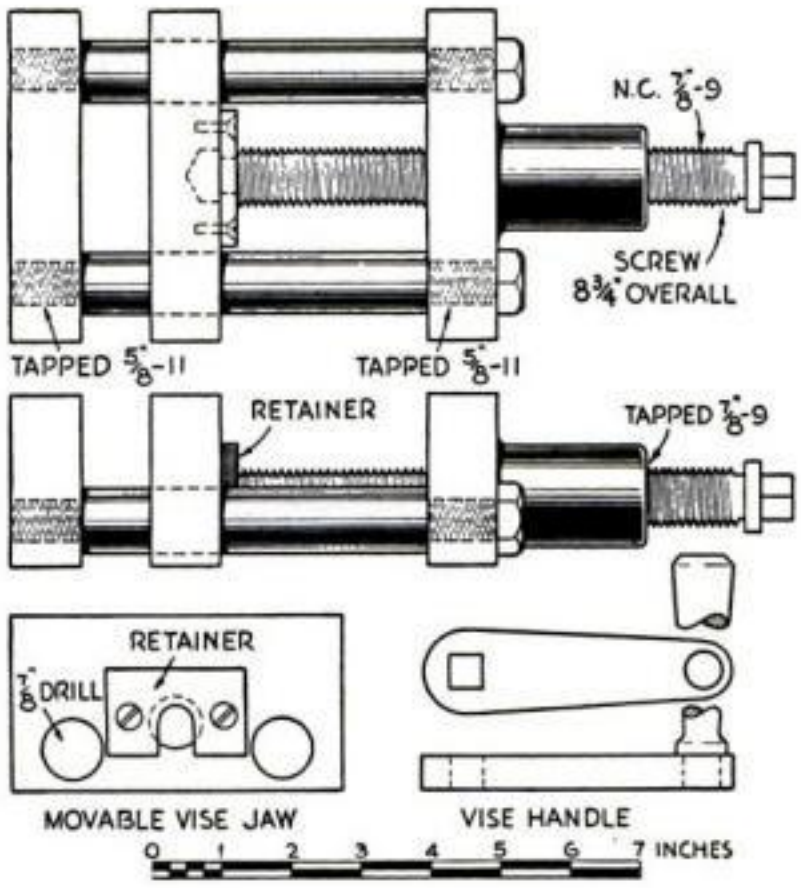
The head end of the vise shown in the accompanying photographs was built from a discarded casting, but this part can be made from steel as in the drawings, or the projecting barrel for the vise screw can be left off, in which case the part will be the same size as the vise jaws. The endpiece and the two jaws must be accurately drilled for the slide-rod holes, otherwise the movable jaw and vise screw will bind when the jaw is being slid along the rod. The stationary jaw is drilled 17/32" and tapped ⅝"-11. The movable jaw is drilled ⅞" to slide on the rods; the head end, ⅝" to clear the threaded rod ends. The head end is also drilled 49/64" and tapped ⅞"-9 for the vise screw. It is necessary also to drill the movable jaw for the end of the vise screw and for the two ¼"-20 screws which hold the retainer in place. The slide-rod threads should be cut in the lathe, for a die cannot be depended on to cut absolutely true.

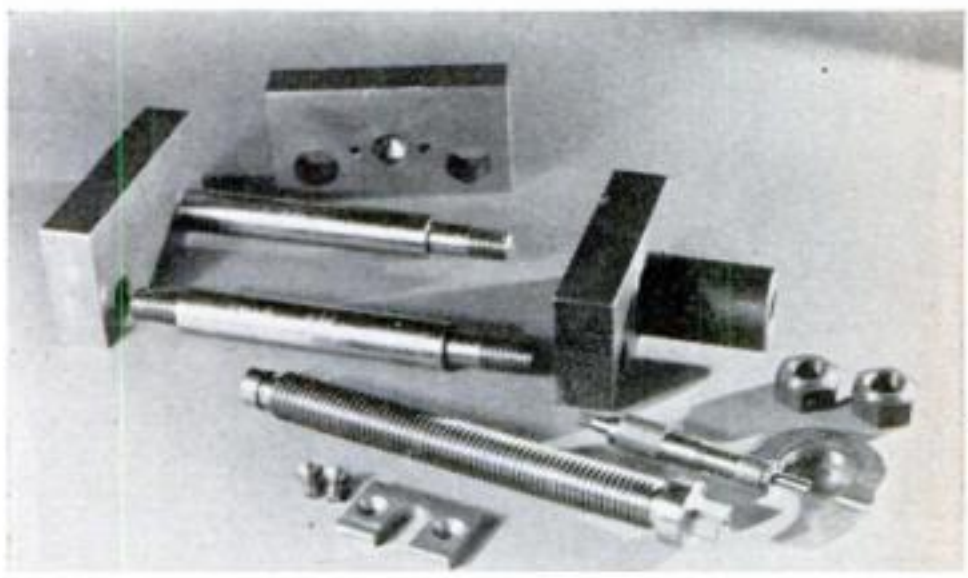
In assembling the drill-press vise, the two slide rods are first screwed into the end jaw and tightened by holding one rod at a time in an ordinary machinist's vise and turning the vise jaw. The movable jaw is slipped on, and then the head end is put in place and tightened with two heavy nuts, turned down thin for better appearance.

The vise screw is made as indicated in the drawings, screwed into place, and fastened to the movable jaw by the retainer. A regular bench-vise handle can be made up for the screw, but a crank-type handle will be found more convenient.



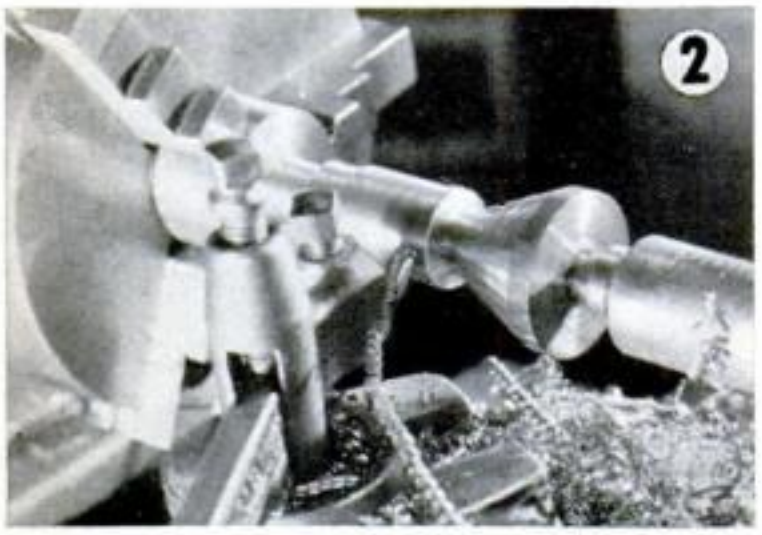
In use on the drill press, the finished vise holds a steel bar firmly in place as the drill bites its way through. The removable crank-type handle is shown beside it

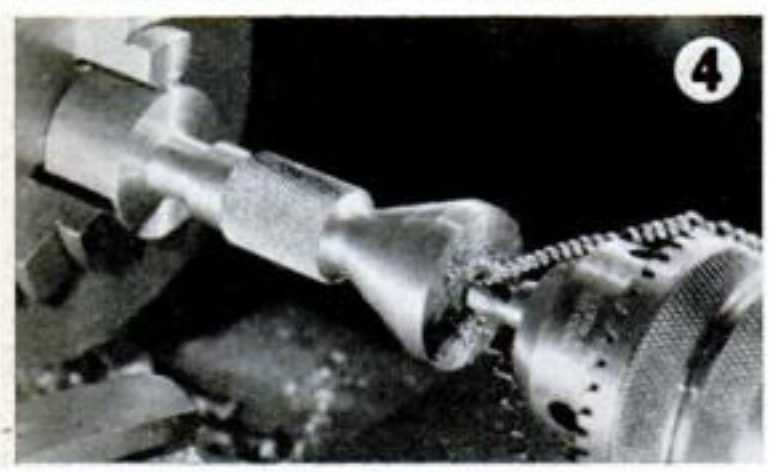


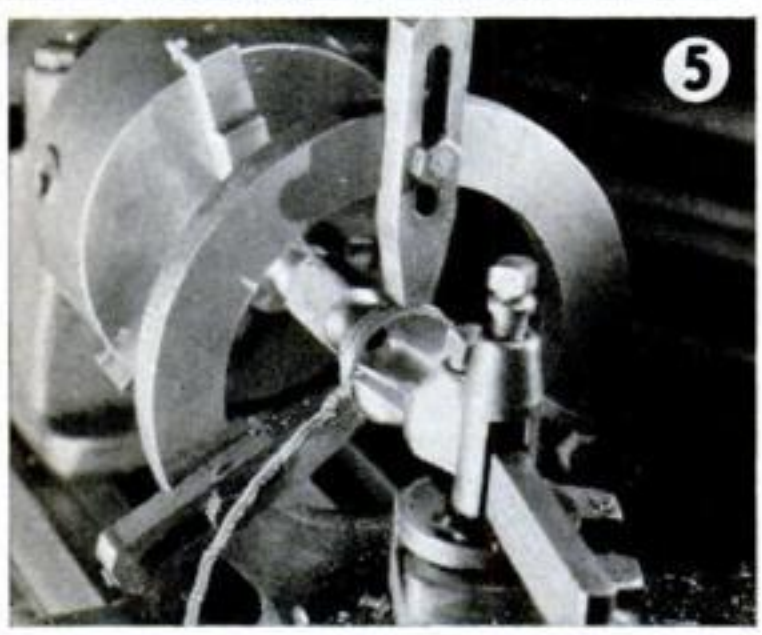


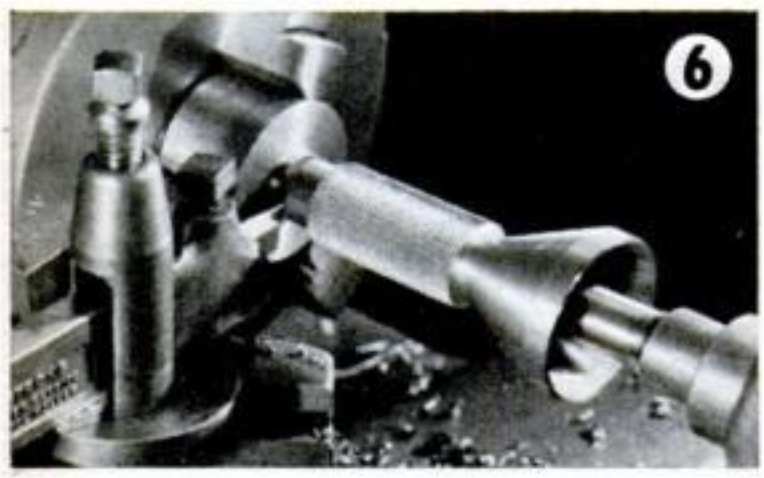
Parts of the drill-press vise as made in a small shop. Holes for the slide rods must be drilled accurately as even a slight error will cause jaws and screw to bind

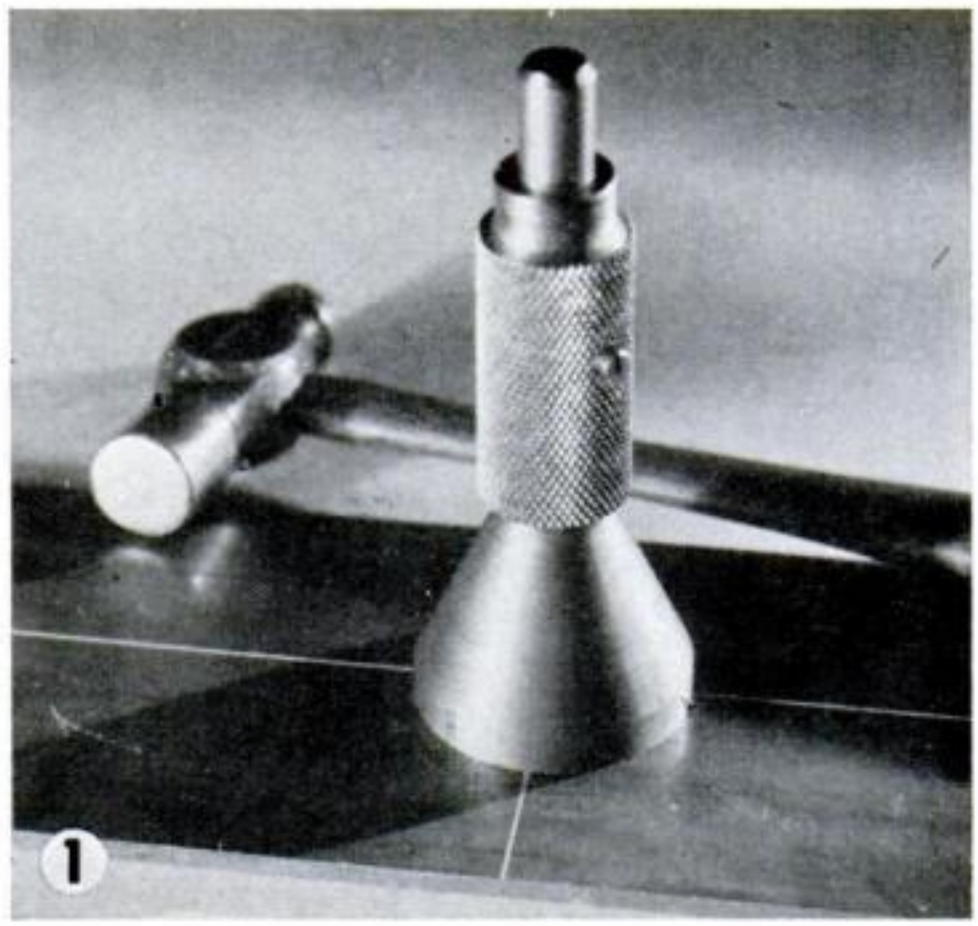
MACHINISTS FOR DEFENSE











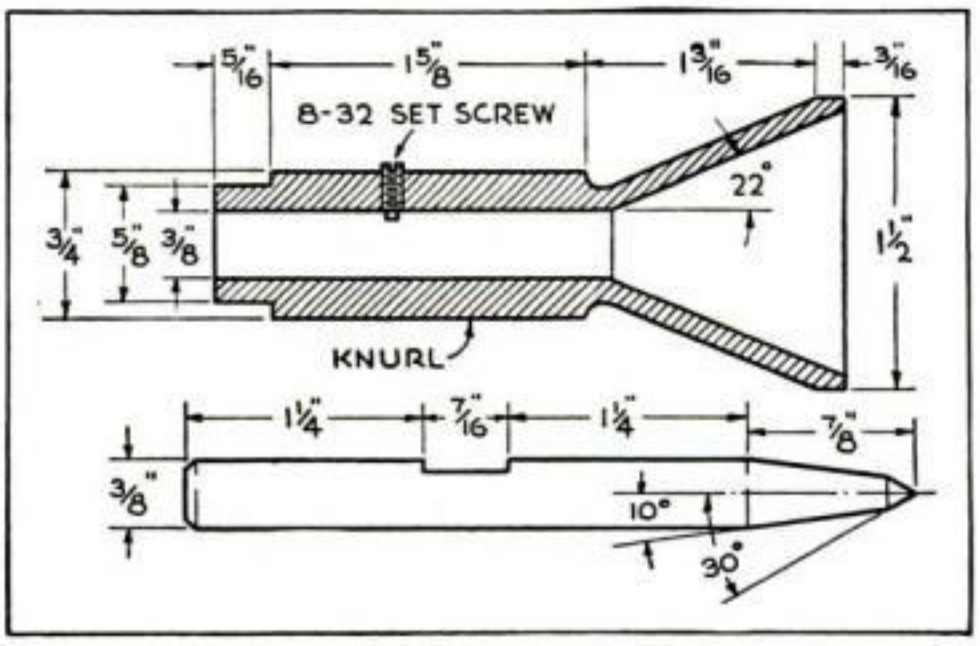
Bell Centering Punch: A Project for Machine-Shop Beginners

IT IS difficult to center-punch work by hand with hair-line accuracy, as the slightest inclination of the punch will shift the mark to one side. With a bell centering holder, such as shown in Fig. 1, however, the punch is held absolutely vertical, and a clean, accurate mark results. The holder must be machined true, and the point of the punch ground exactly concentric with its axis.

The holder can be turned to shape from mild steel while held, as illustrated in Fig. 2, in the three-jaw chuck and supported by the tailstock center.

Knurl the ¾" diameter (Fig. 3), using a medium knurl, slow speed, and plenty of oil. With the knurls sunk deep in the work, the power feed of the lathe should be engaged and the tool traversed back and forth until the diamond-shaped projections on the holder are well formed.

At the same chucking, drill the piece through



with an 11/32" drill (Fig. 4); then ream to ⅜". The next step is to support the bell-shaped base in the steady rest and bore it out, as in Fig. 5. Supported as in Fig. 6, the wide base is trued square, and the piece cut off with a parting tool.

Drill and tap the hole for the set screw that holds the punch in place.

The center punch is next turned from tool steel or drill rod to a close sliding fit in the holder. Harden and temper the punch, and then grind the point to shape, being sure to remember that it must be done with exactness. This operation is best performed with a tool-post grinder.

When using the punch on work laid out with scribed lines, such as shown in Fig. 1, simply slide the point along a line until it drops into the intersecting one; then tap the punch lightly with a hammer. The resulting mark will be located with a high degree of accuracy.

This Sturdy Knurl Holder Is Useful in the Machinist's Kit

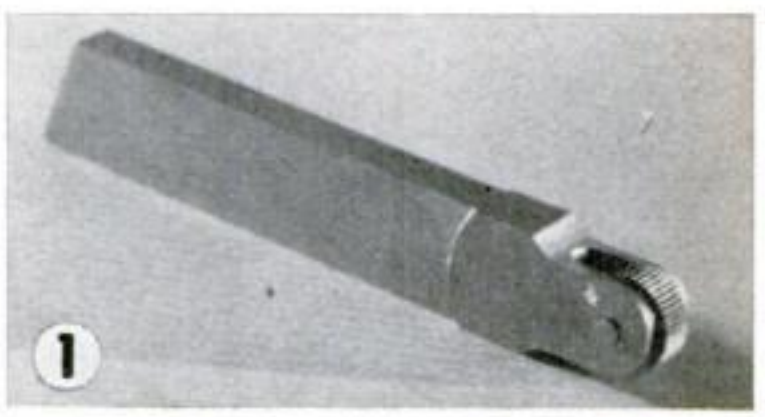
KNURLING in the lathe, both straight and diamond, imparts a fine, finished appearance to small work, such as tool handles, thumb screws, and so on. A holder for the knurling tool, like that shown in Fig. 1, is easily made, and will help to simplify the job of knurling. The pin can be removed and the type of knurl changed to suit the work in hand.

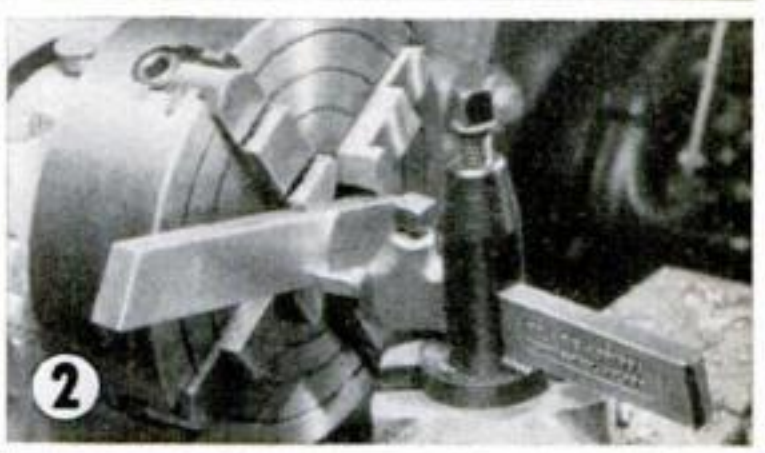
This holder is designed for use in a 9" lathe with a ⅜" slot in its tool post, and was made from a good grade of machine steel ½" by ⅞" by 5¼". The shank can be cut down to fit the slot in several ways, the lathe having been used in this case. With the steel blank chucked, as illustrated in Fig. 2, 1/16" of the flat side of the shank is cut away; the work is then reversed in the chuck and the same amount cut from the other side in a similar manner.

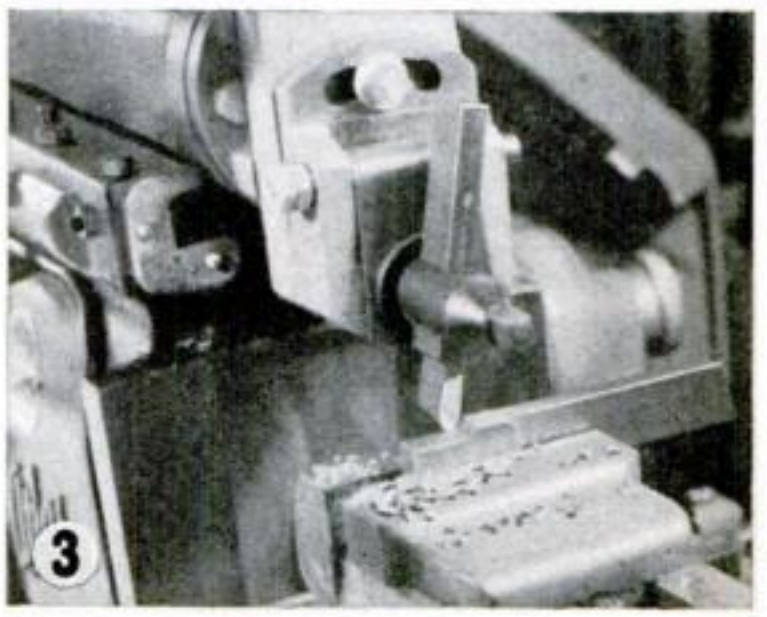
The end that holds the knurl should next be reduced in height on the shaper as shown in Fig. 3, or filed by hand, to slightly below the diameter of the knurl used.

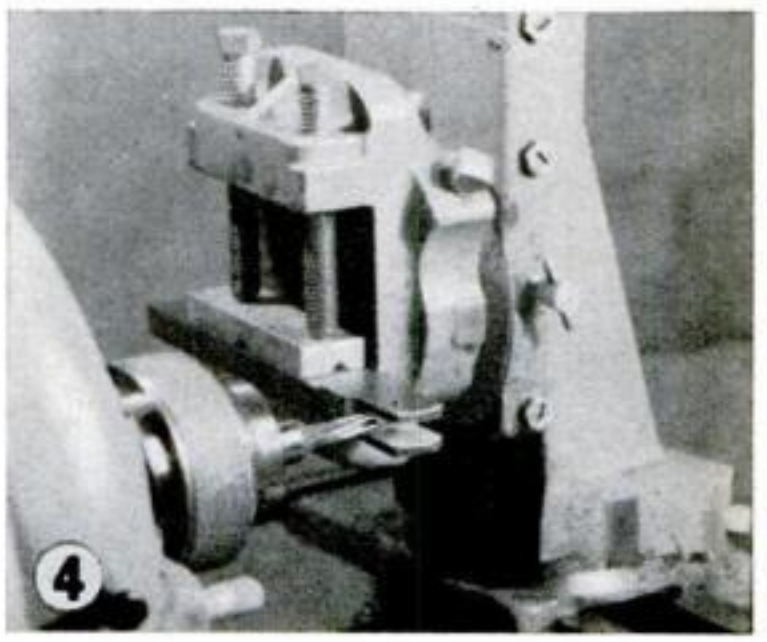
The slot is next cut in the milling attachment (Fig. 4), and the hole for the removable pin then is drilled. The pin should be a drive fit in the hole, but of a size to allow the knurl to revolve on it freely.

Knurling requires considerable pressure, so the work should either be held between centers or chucked and supported by the tailstock center as on the facing page in Fig. 3, illustrating the preceding article. The work, the knurl, and the center should be well lubricated, and high speeds avoided.—C. W. W.

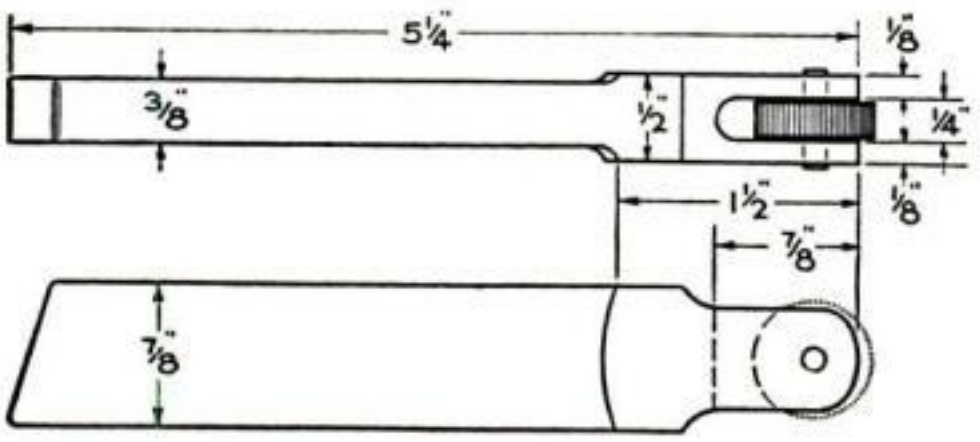


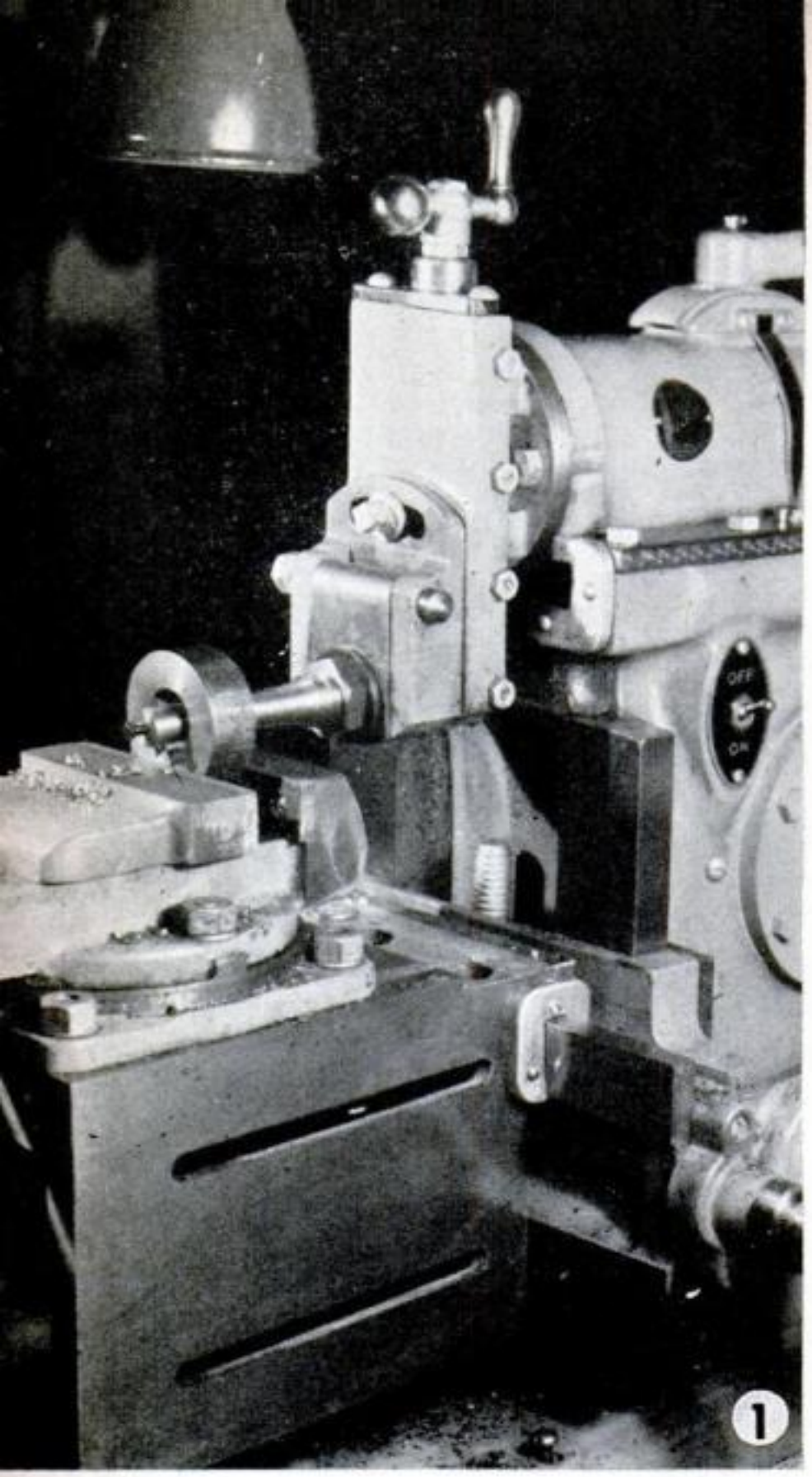






A single steel blank is needed for making the knurling-tool holder, which is shaped to the dimensions below





Required for internal work, this extension tool holder will increase the versatility of a small shaper. It is made from a 1¼" diameter steel bar and a short piece of hexagon rod, following the steps in the photos below and on the facing page

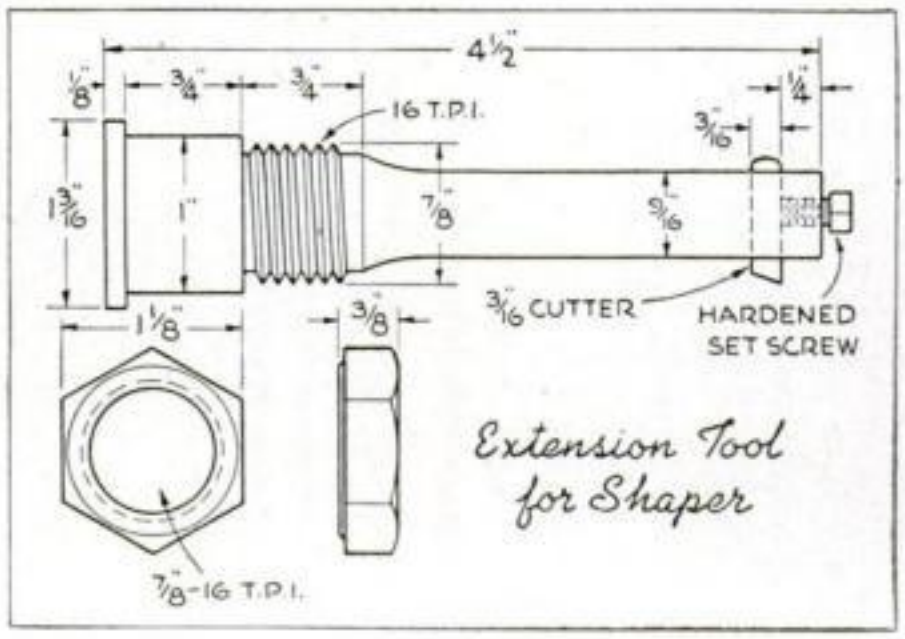
Extension Tool

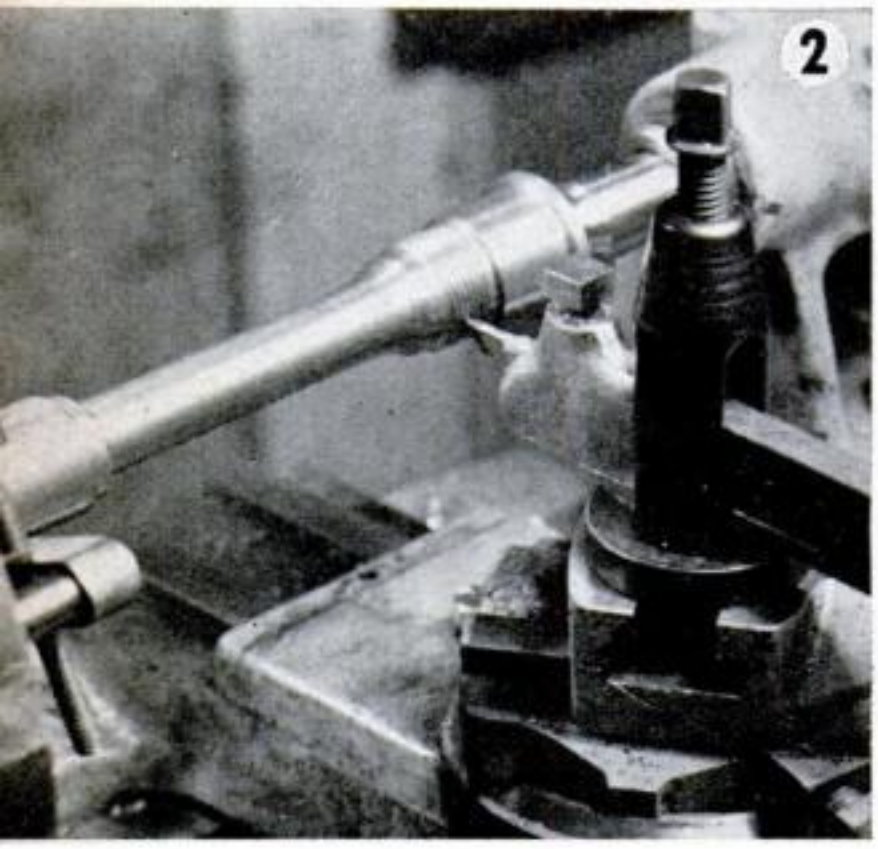
CUTS INTERNAL

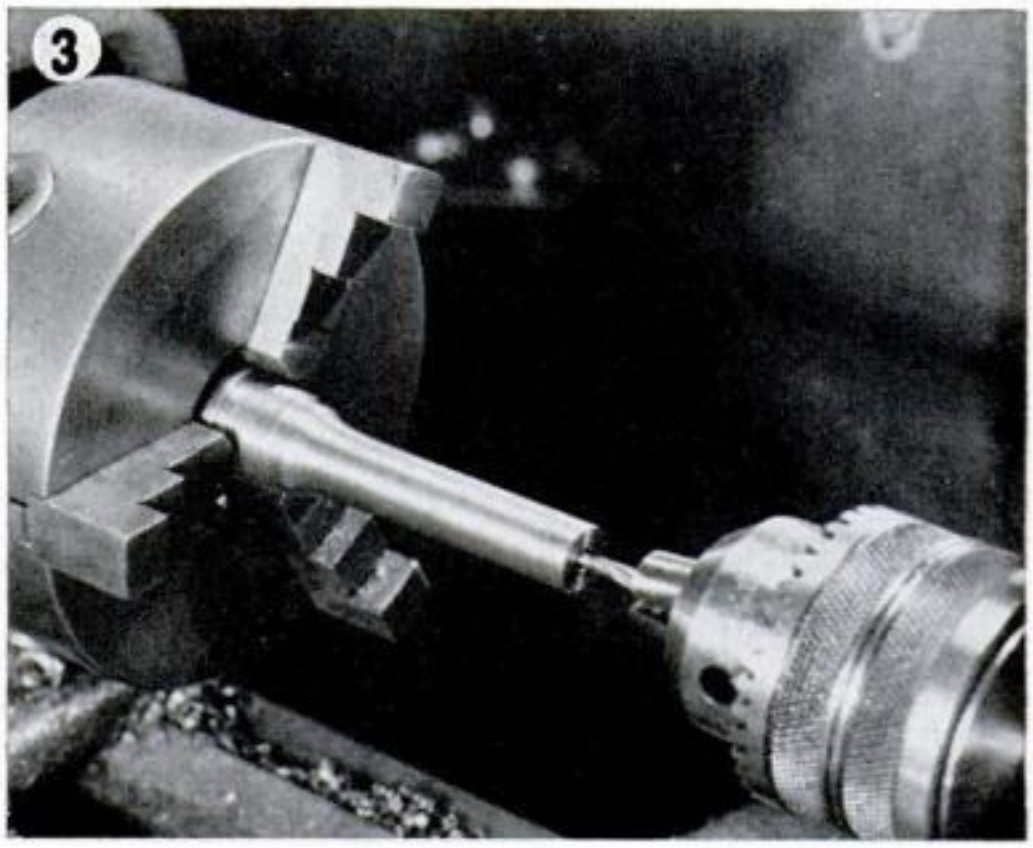
By C. W. WOODSON

THE practical extension tool holder illustrated in Fig. 1 enables a small shaper to cut splines and keyways and do other internal work. With the exception of cutting a hole for the tool bit, all operations in making it are performed in the lathe. A 1¼" diameter steel bar is chucked, center-drilled for tailstock support, turned to size, and threaded 16 threads per inch as in Fig. 2 to receive the nut which clamps it securely to the clapper in place of the regular shaper tool post. The overall length of 4½"

As shown in the drawing, the tool holder can be turned from a bar 4½" long. The dimensions given should be altered, if this is necessary, to suit the shaper on which the extension is to be used







Holder for Small Shaper

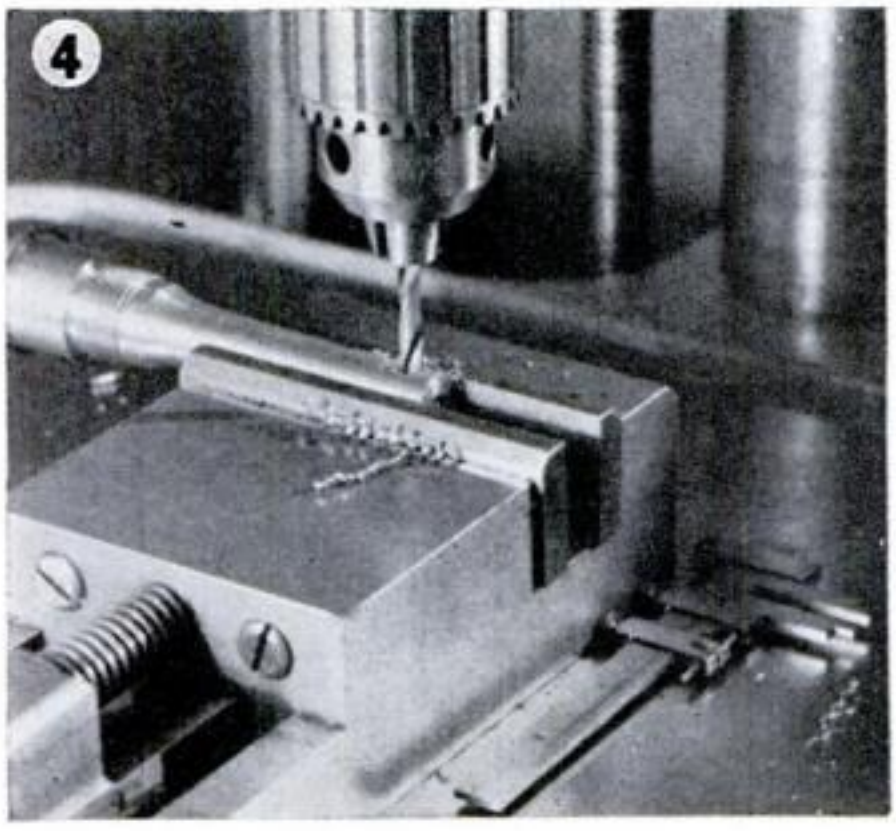
KEYWAYS AND SPLINES

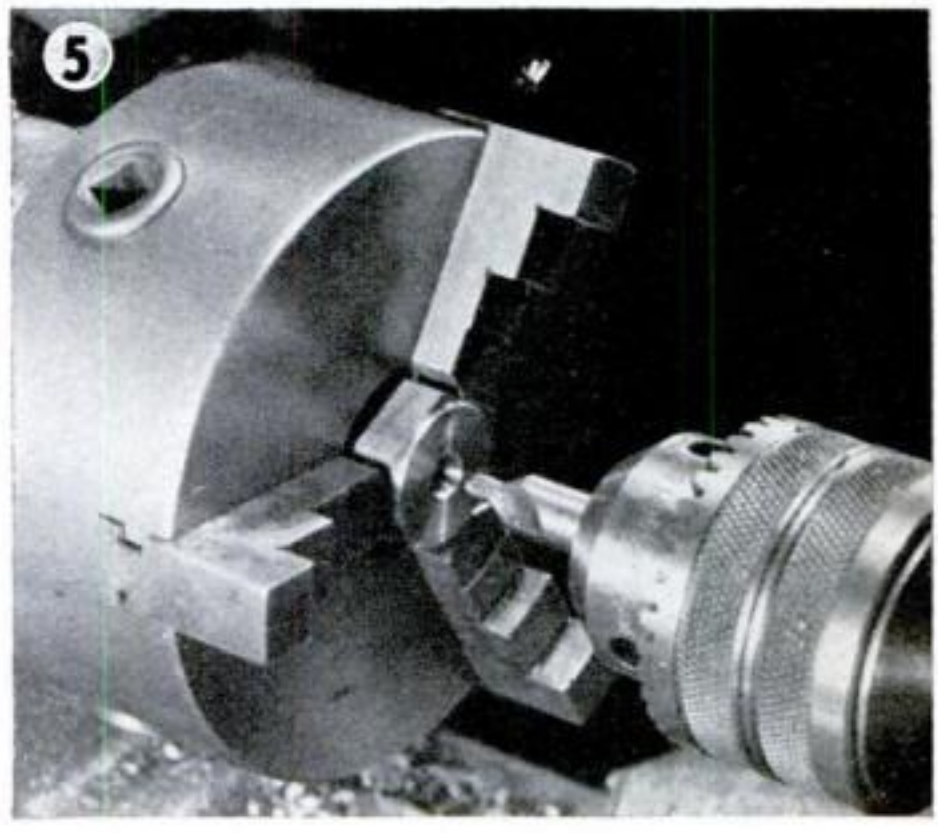
should be sufficient for any internal work required of a shaper of this size. The other dimensions given in the accompanying drawing are intended to fit a typical small machine; they should, of course, be altered if necessary to suit the clapper of the particular shaper on which the tool holder is to be used.

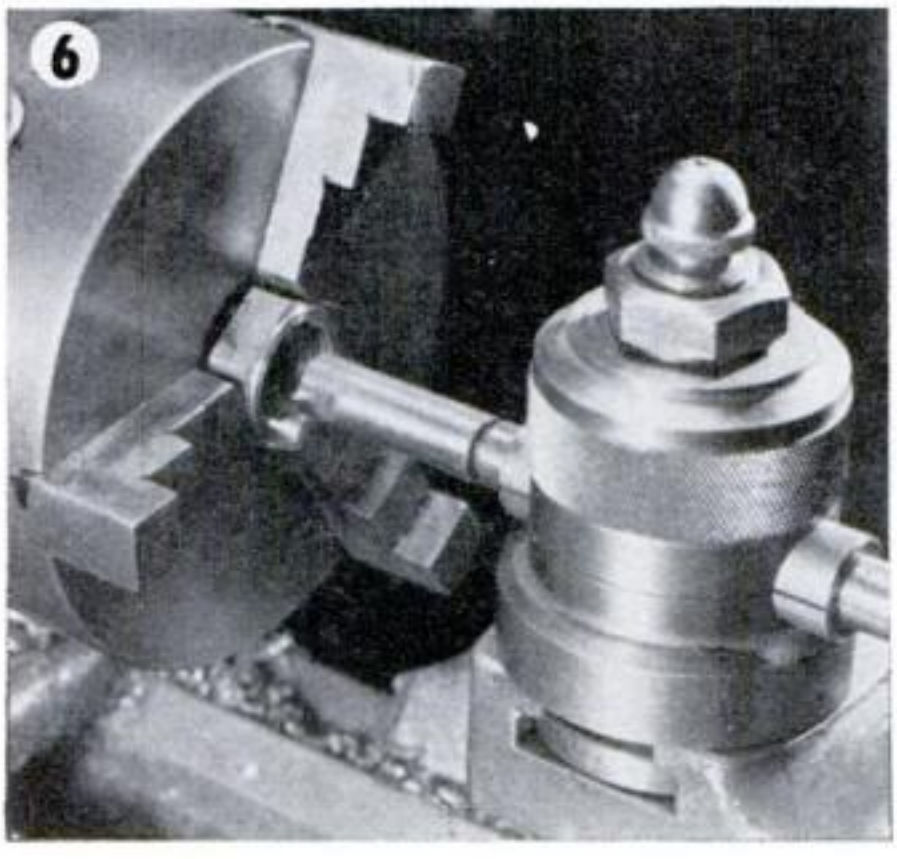
Drill a hole in the end of the holder with a No. 21 size drill while the work is chucked in the lathe as in Fig. 3, and tap it 10-32 for a hardened set screw. Figure 4 shows the initial step in cutting the hole for the tool bit, which is first drilled 3/16" in diameter and afterwards filed square by hand.

The nut that clamps the tool holder to the clapper is turned to ⅜" thick from a piece of hexagon steel rod while it is chucked as in Fig. 5, centerdrilled, and bored out to a diameter of 13/16". In Fig. 6 an internal thread-cutting tool is being used to cut 16 threads per inch in this nut. As 16 is a multiple of the pitch of the lead screw on the lathe (8 threads per inch), this thread can be cut very quickly without the use of a thread dial indicator.

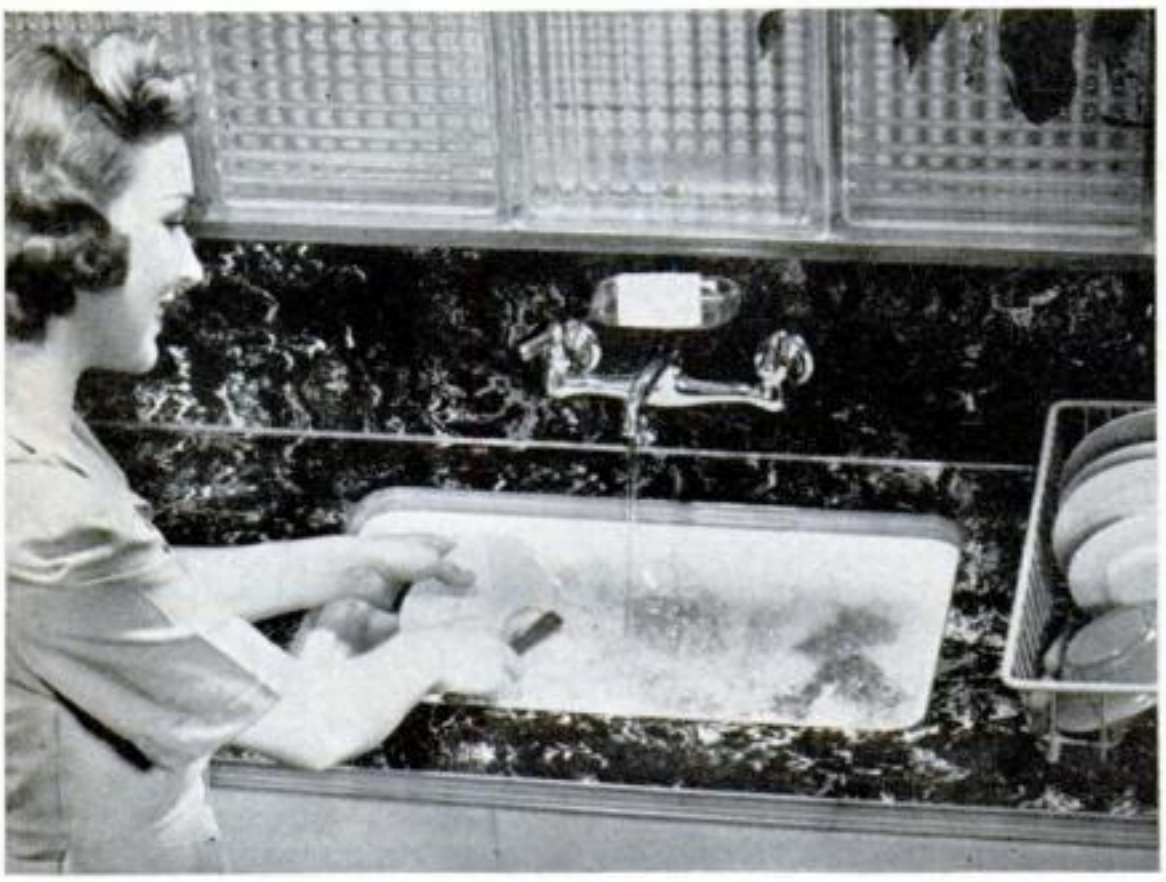
The finished tool holder with a bit in place is shown in Fig. 7.



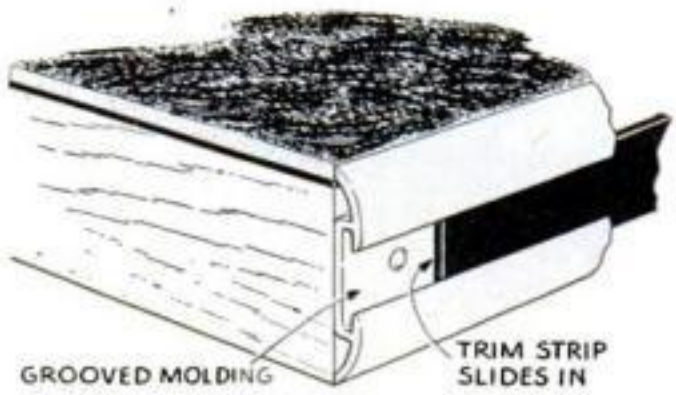




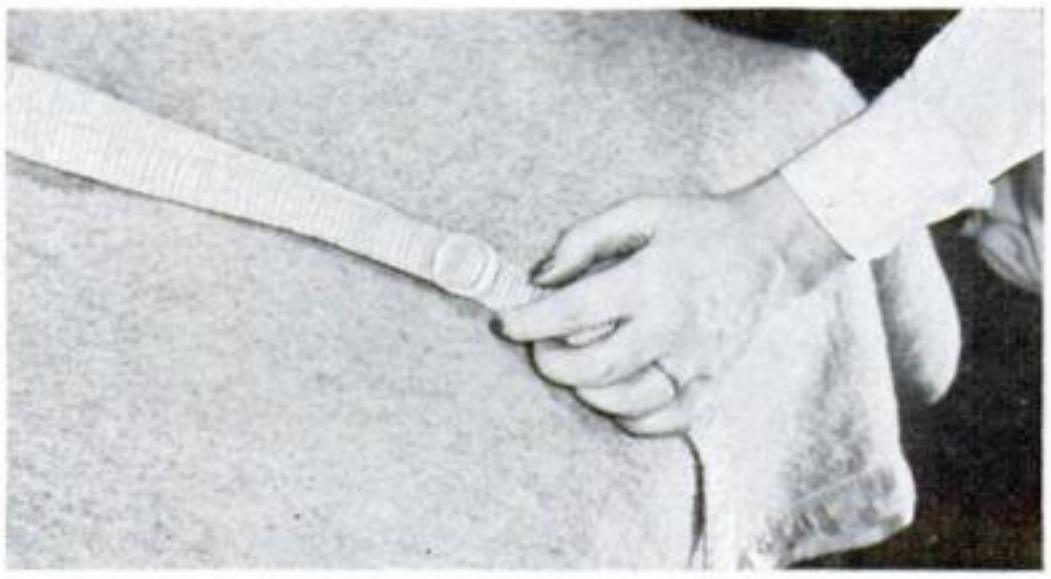
New Appliances



PLASTIC STRIPS for replacing aluminum trim on sinks, shelves, and tables come in a variety of colors with a contrasting insert. The edging has a noncorrosive, washable finish that will resist chipping and peeling. It is made in several shapes and sizes, and inserts may be bought separately to suit individual color schemes

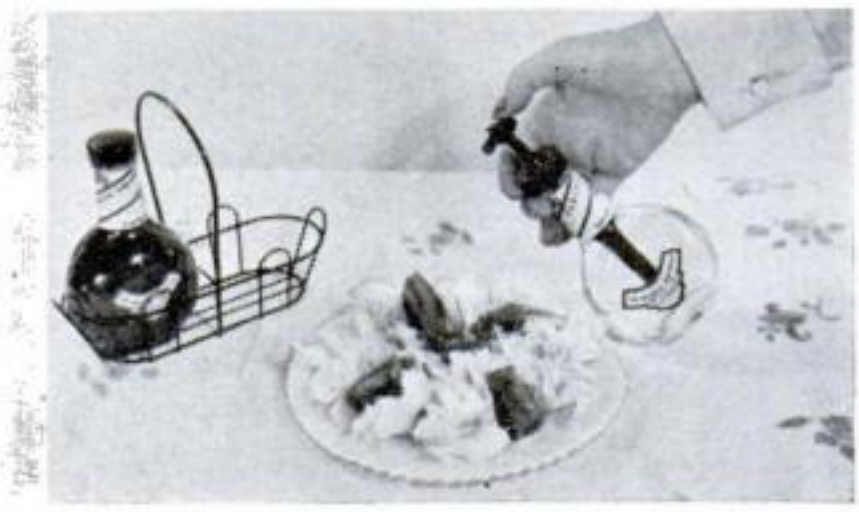


HOLDING A BALKY COMFORTER or an undersized blanket securely on a bed is simplified with the use of an elastic ribbon. One recently introduced hooks onto box, coil, or link springs, and is stretched over the cover near the foot of the bed. The bands are made in two sizes, adults' and children's, and can be adjusted within their range. Only one ribbon is needed with larger beds, but for cribs two are used. One set of hooks has been designed for either coil or link springs, and another for box. Both the ribbon and hooks are in colors

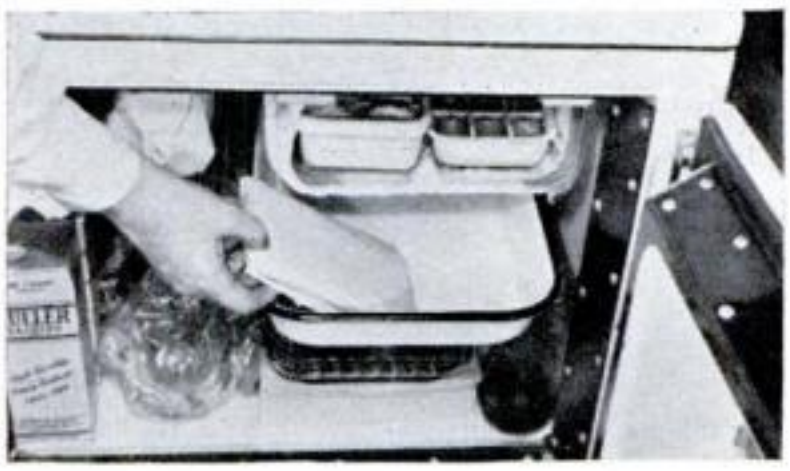


SPICE-FILLED JARS, having shaker tops that can be unscrewed when the condiment is to be used in measured amounts, are on the market. A metal disk, which fits under the perforations in the top, can be rotated to shut out dust and seal in the flavor when the jars are reposing on the kitchen shelf. The assortment now available consists of five popular kitchen and salad spices—nutmeg, paprika, onion salt, allspice, and celery salt

SPRAYING VINEGAR OR SALAD DRESSING is possible with a set of dining accessories, which includes a red, enameled metal basket, two filled carafes, and a special plastic sprayer-pump. The pump can be screwed into the top of either of the bottles, and comes in a choice of colors. There are two different selections of dressings offered in the set, one with French and onion dressing, and the other with both wine and tarragon vinegar

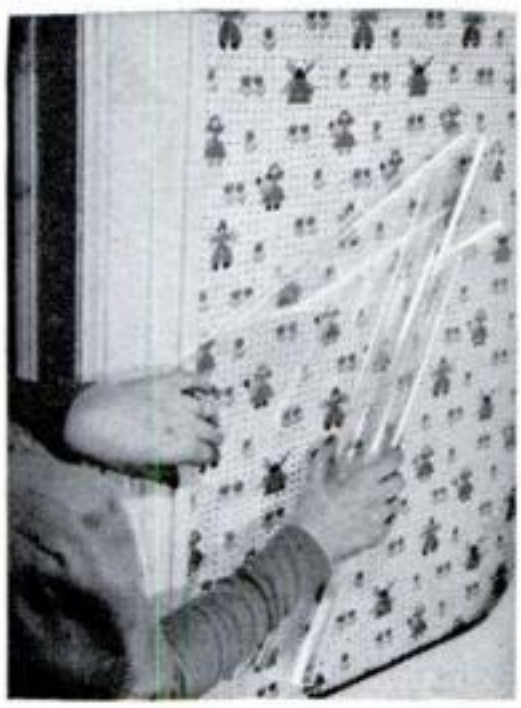


for the Household



REFRIGERATOR PAPER, waxed on one side, is moisture- and vaporproof, and odorless. Wrapped around meat, the waxed side in, as in the two photos above, it will prevent "freezer burn," dehydration, and sticking

COOKIE CUTTING becomes a semiautomatic operation as the steel-spring plunger in the cutter (right) is pressed and releases the cut dough from the cup. The first and second fingers are hooked in the rings to grip the cutter firmly, and the plunger is pressed down with the thumb. The rings are molded to the top in a natural position. The steel spring attached to the plunger holds it in place



CLEAR PLASTIC SHEETS in sizes 20" by 50" give protection to walls behind kitchen stoves and sinks, or they can be used around bathtubs and wash basins, in playrooms, or, cut in small pieces, around wall switches. The sheeting is attached to the wall with transparent gummed tape, which is furnished with each roll. The material can be washed or cleaned with a dampened cloth, and it also will resist heat

GREATER SINK DISPOSAL CAPACITY, more compactness, and fewer parts are refinements now available in an improved electric sink disposal unit made by one of the large electric companies. As in earlier models, it receives kitchen waste, grinding and shredding it, and finally pumping it into the plumbing drain line where it immediately runs away. Two entrance flanges, standard and large size, are available

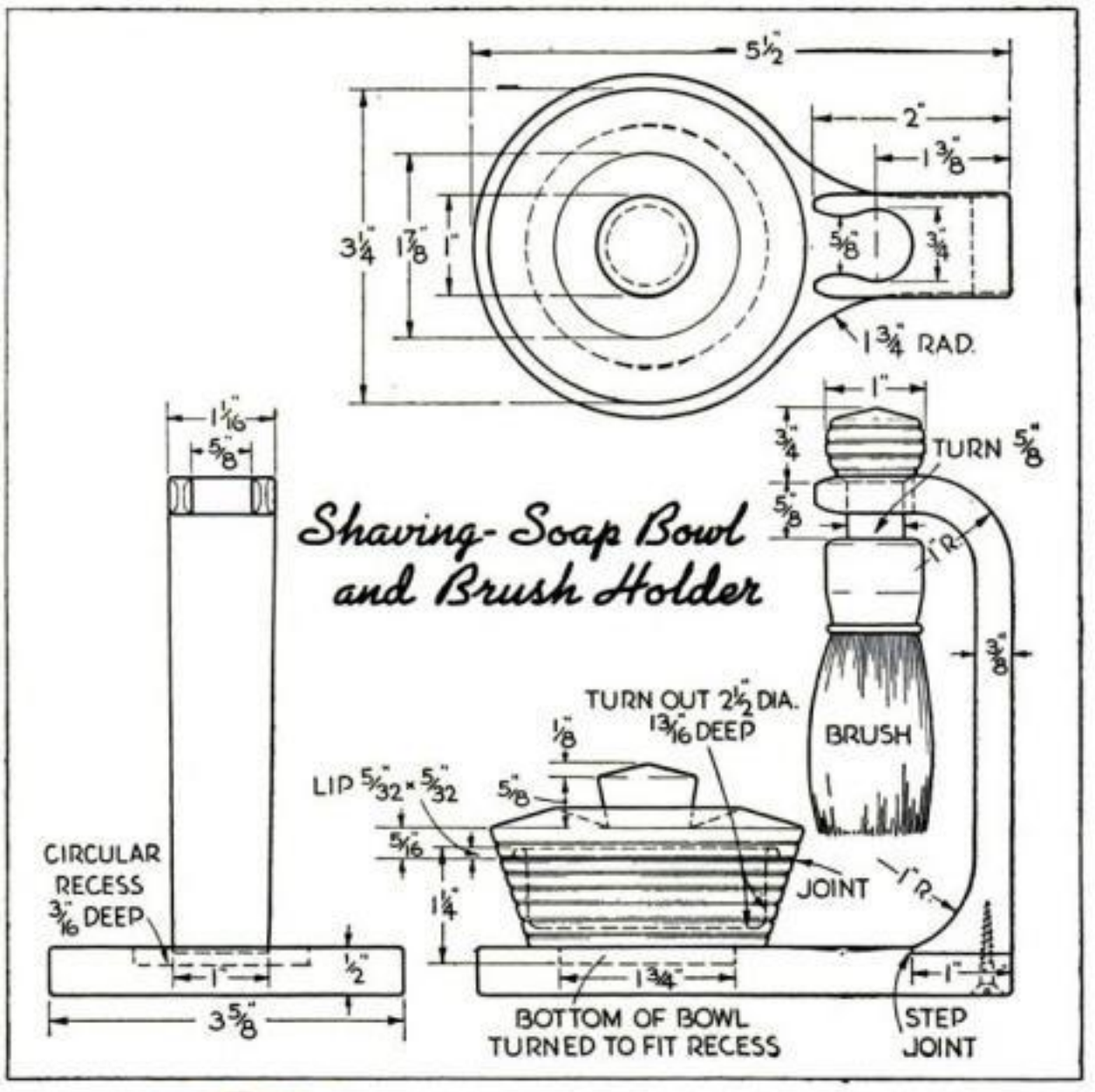
Only 20½" high, the new disposal unit has double the old capacity. Its operation has been made nearly noiseless, its speed increased

Shaving-Soap Bowl and Brush Holder

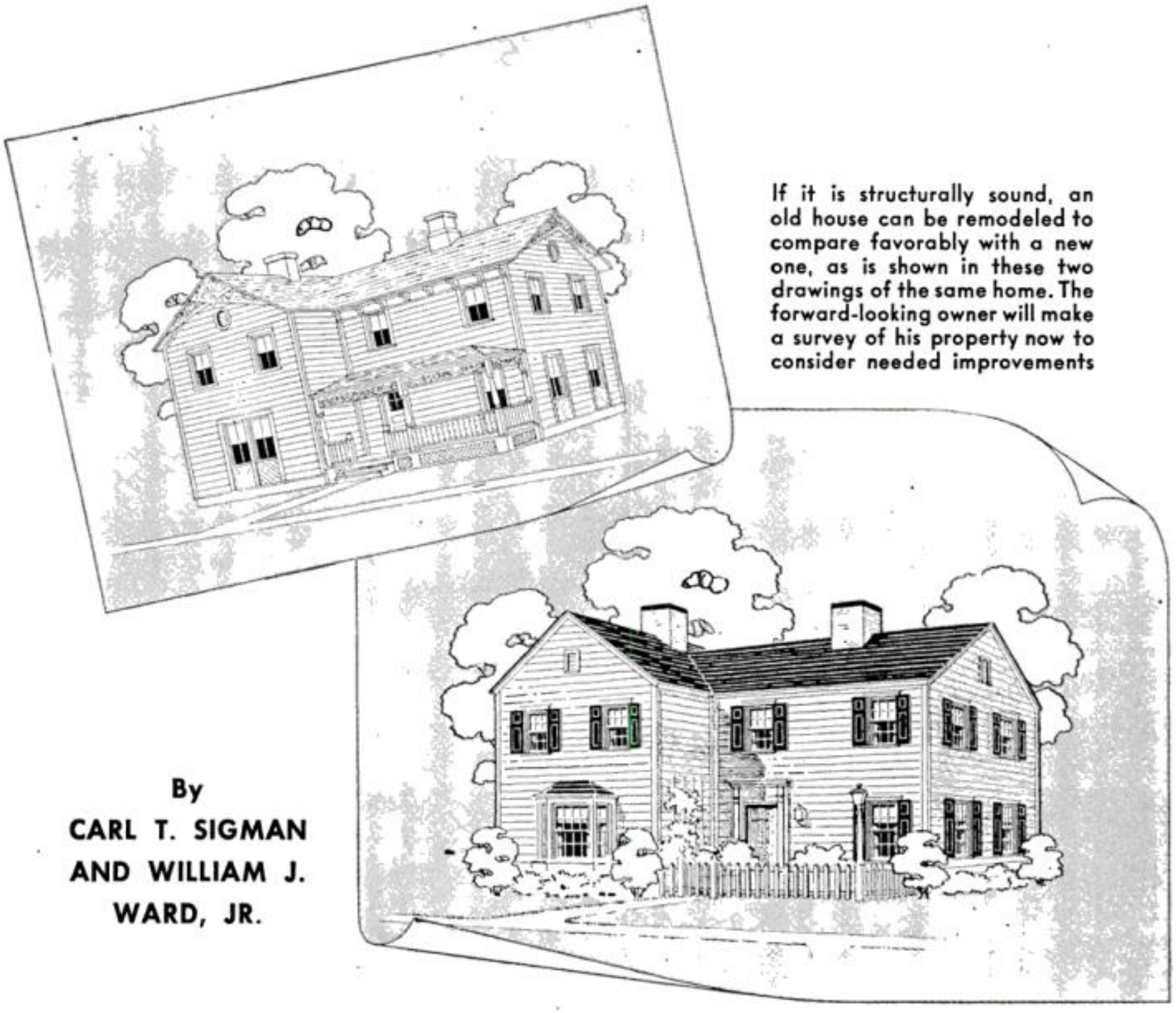
MEMBERS of the brush-and-lather school of shaving will welcome this soap and brush holder. Made of maple, it is an interesting but not difficult turning project.

The brush standard is designed for a stock-size professional brush having bristles 2" long. The handle is turned down to 5/8" at the neck or a new one of that size is made. Band-saw the holder fork from 1 1/16" stock after drilling a 3/4" hole where the throat is to be; then cut down to this hole to form the fork that holds the brush.

The base is sawed to shape and mounted on a faceplate so that a 3/16" deep recess can be turned to receive the soap cup. This is made to hold a commercial shaving-soap cake, and the bottom is step-turned to fit the base recess. Make the lid with a rim to fit over the lip of the cup. Space the decorative grooves 5/32" apart to give the effect of a single turning from top to bottom. Finish all parts with two coats of clear varnish; then give the inside of the bowl one extra coat. Working time, 6 hours.



A turned step on the bottom of the cup fits into the base recess. Use waterproof glue and one wood screw to join base and upright. The entire piece may be finished in enamel instead of varnish to suit a bathroom color scheme, if preferred



If it is structurally sound, an old house can be remodeled to compare favorably with a new one, as is shown in these two drawings of the same home. The forward-looking owner will make a survey of his property now to consider needed improvements

By
CARL T. SIGMAN
AND WILLIAM J.
WARD, JR.

Improve Your Home . . . NOW

IN TIMES past, when part of the plumbing went bad or you needed a new kitchen range or wished to install a new shower, you went to a hardware store or plumbers' supply house and bought what you wanted. But defense needs are rapidly altering the circumstances under which we live. Serious shortages of many materials, including those necessary for keeping your home in repair, are threatened. It may be difficult, if not impossible, to build or buy a new home for several years to come. Therefore, if you own or rent a house, it will pay you to put it in good repair and keep it so. In fact, an old house can be repaired or remodeled until it looks—and is—practically as good as a new one.

Because defense needs are likely to increase rather than decrease, it is wise to take stock now and make such alterations as are necessary while the materials can be had without diverting them from government requirements. Aluminum is, of course, already unavailable for home use, as is copper except for wiring purposes.

Recognizing the urgency of the situation, POPULAR SCIENCE has a series of articles in preparation on things to be done to keep your house in repair. Meanwhile, you might well add these two to your other New Year resolutions:

1. "I'm going to inspect my house from cellar floor to attic ceiling inside, and from footing to roof outside, and note anything that may require replacement during the next four or five years.

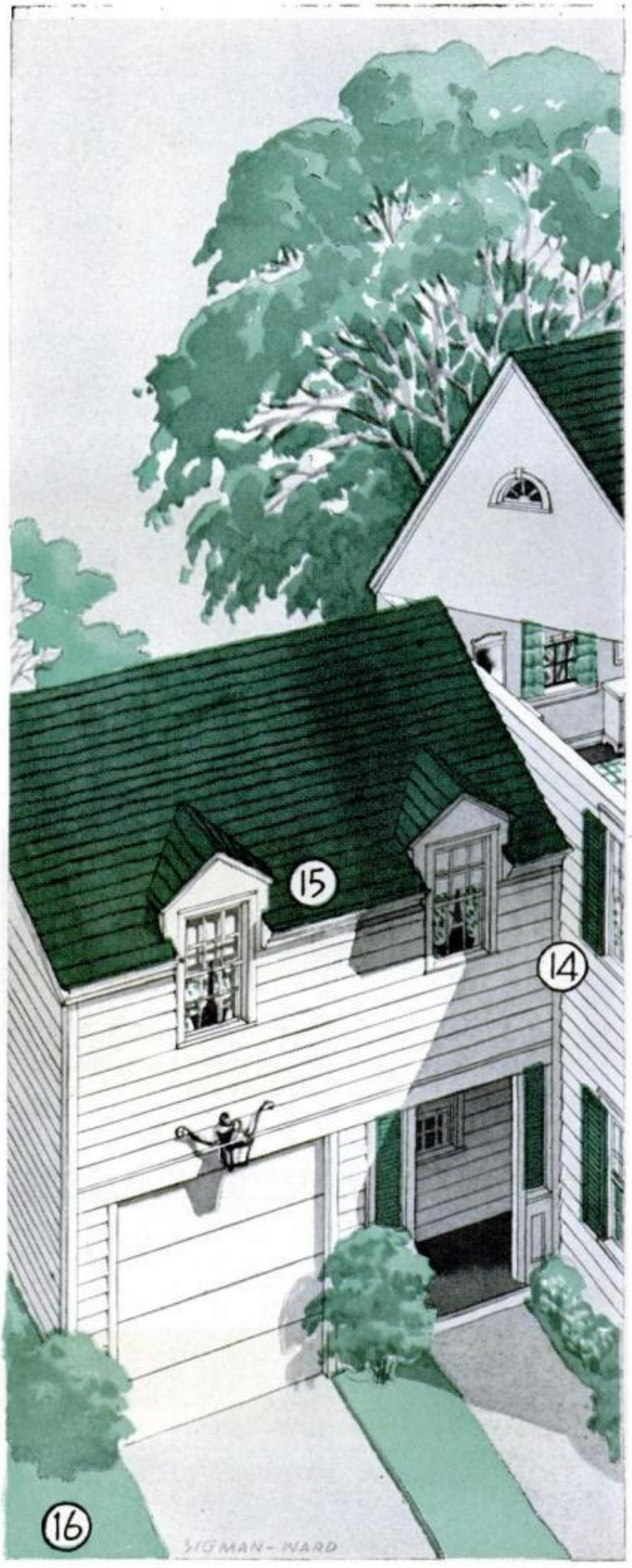
2. "I'm going to buy the materials I need while Uncle Sam can spare them. I'm going to make all possible repairs *now*."

Look first at your furnace. Is it operating satisfactorily? If any parts must be replaced, order them at once. This spring, it would be wise to give it a complete overhaul, with your heating contractor's advice and assistance if necessary. Thorough cleaning is important, because a 3/16" deposit of soot in the flues may cut the efficiency in half. This may also be the time to consider installing a gas or oil burner, or a stoker. If you already have such automatic equip-

What You Can Do to Repair and Modernize Your Home

Here is a check list of suggested house repairs and improvements. All numbers refer to the drawing.

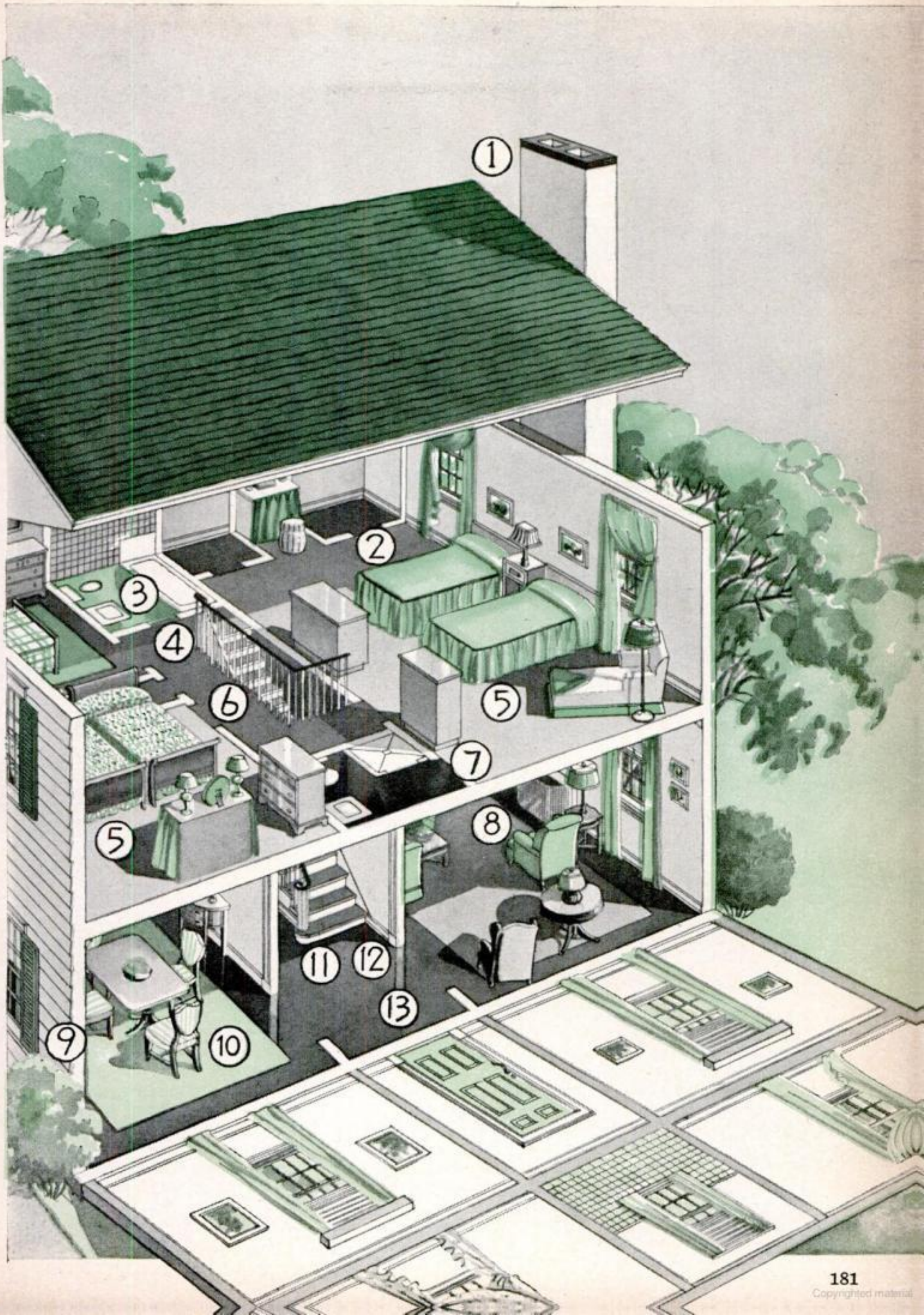
1. Repoint and repaint the chimney.
2. Remodel closets for maximum convenience. Build a dressing table between two if feasible.
3. Refinish the bathroom with a tile or imitation-tile wainscoting and lay a new linoleum floor.
4. Renail creaking floors.
5. Scrape and refinish floors.
6. Redesign the linen closet to hold specific material.
7. Install another bathroom.
8. Repoint the fireplace fire brick; install a new damper unit.
9. Buy enough screening to renew window and porch screens.
10. Build in adequate linen, silver, and dish storage cabinets in the dining room.
11. Modernize stairs to basement, second floor, and attic..
12. Fill wall cracks, remove stains; paint or repaper walls.
13. Consider linoleum for covering hall floors.
14. See that windows are well puttied and caulked.
15. Keep gutters and leaders free of leaves, acorns, and sediment, and well painted.
16. Install overhead doors in your garage.



ment, check it at the first opportunity. Look at the smoke pipe also—is it likely to last four years more?

A booster or circulator in a hot-water heating system, or a blower in a hot-air system, improves its efficiency, saves fuel, and becomes a self-liquidating investment. Even if you do not wish to install one at present, buy the equipment now, if possible.

Inspect the asbestos covering on steam and hot-water supply lines. Are all elbows and joints covered, as well as straight runs? You can lose much



Where space is a problem, you can install a lunch bar. This one serves also as a shelf for the counter pass between the kitchen and dining room

heat from uncovered elbows. Before applying new asbestos, examine all joints for leaks. Paint all return lines with a good heat-resistant paint. Covering hot-water pipes, if they are not already jacketed, will save fuel.

Plumbing is always a vulnerable point. Have you recently cleaned out the traps in the soil pipes? This may well be included in any general overhauling. If spring rains flood your basement yearly, perhaps you should get a sump pump now.

Are there cracks in your cellar walls? Chip them out to a dovetail shape and point them up with cement mortar.

Examine girders, beams, and sills for rot and termites, using an ice pick in one hand and a flashlight in the other. If you find soft spots, take steps to replace the damaged wood and to impregnate good wood with chemicals to make it termiteproof. Probably you will have to call upon your local exterminator for help.

Have beams shrunk away from supporting columns? Then drive wedges between the two parts. Very annoying is a floor that shakes when some one walks across it. A girder under the floor joists and at right angles to them, supported by a Lally column or columns, will correct that condition. This is a problem that should be considered at once, because steel I-beams and Lally columns are going to be hard to get. Break up the basement floor first and build adequate footings under the columns.

Although not so urgent, it is a good idea to take a length of pipe and tap the cellar floor all over. If you find an extensive hollow space anywhere, break up that section, fill the hollow with cinders, and tamp well before relaying the floor.

Cellar stairs are frequently too steep, poorly lighted, and with inadequate handrails or none at all. As a safety measure, have them rebuilt, if necessary.

New electric refrigerators may become increasingly difficult to obtain. Keep the one you have well oiled and defrost it regularly. Your gas or electric range has to last, too, so inspect it. If you have a sink garbage-disposal unit, see that the lubricating cups are kept filled with oil at all times. Fill all cracks in the tile around the sink. Renew the counter tops if necessary with linoleum, tile, pressed wood, or other material.

This may be a good time to consider whether you have enough convenience outlets in the kitchen and elsewhere. An extra one will provide current for an electric clock, or make it easier to use an electric shaver in the bathroom. If you install extra outlets yourself, remember that the work must conform to the National Electrical Code and that it must be inspected by the proper authorities. Another likely spot for extra outlets is the mantelpiece. Nor should you overlook the convenience of receptacles in the garage and in strategic locations outdoors, where they can provide light for night picnics, for working on the car after dark, and so forth.

If your living-room fireplace doesn't draw well, now may be the time to install a metal damper unit. See if the fire-brick lining needs repointing with fire clay.

Now is the time to replace old or worn valves on your radiators. Good valves make a big difference in the efficiency of any heating system. It may well be that you have been planning to install a time-controlled thermostat, or an aquastat or hydrostat. Such installations make for greater comfort, save fuel, and become a real asset in helping to sell your house if ever you wish to do so.

In the general refurbishing of your home,

of course, all cracks and stains on the walls should be patched or removed. Loose boards of hardwood floors should be renailed with long finishing nails, and unsightly floors rescraped and refinished. You can lay new floors right over old by using heavy flooring felt or paper between. Hardwood floors assembled in sections can be put down over old floors in the same way.

On the second floor, inspect the bathroom for threatened difficulties. First, see that flush-tank hardware will last. Buy any parts that may need replacement, and put them away. Keep the lavatory drain cleaned out. Don't merely use lye and a "plumbers' snake." Take it apart and clean out the drain. Replace leaky washers and keep a supply on hand. Repoint tile where necessary and all cracks around tub and shower. Consider remodeling with imitation tile wall boards if your bathroom walls are plain.

If yours is a one-bathroom house, give thought now to the matter of a second bath, preferably off the master bedroom. Few investments do more to improve the resale value of a house, or add more to its comfort and convenience. A downstairs lavatory also is a real investment in comfort and increased valuation.

Finally, climb up to the attic to see if there are any evidences of leaks. Roof repairs are to be discussed at length later, but if you think you will need some galvanized iron for the purpose, it might be well to buy it now. The same applies to metal gutters. Keep these free of leaves, particularly oak leaves, which are very acid.

Built-in fixtures are a great contribution to the convenience and neatness of any home. You might consider dish cabinets for the kitchen, and silver or linen cabinets for the dining room. A pass cabinet between kitchen and dining room may simplify serving and save steps. Would a refreshment bar in the kitchen save time in giving the children breakfast and lunch on busy schooldays?

No house seems ever to have adequate bookshelves or cabinets for games and card tables. "Upset" houses are usually so because storage space has never been specifically provided for a great many things. Have you a proper place to keep your hunting rifles, fishing tackle, golf bags, photographic equipment, tennis rackets, and other personal treasures? Plan closets or cabinets around your equipment. Be sure to include space for hunting coats and boots, which every wife seems, curiously enough, to dislike finding next to her evening clothes.

Is your second-floor linen closet big enough? Has it compartments and drawers for towels, sheets, pillow cases, and blankets so that these items can be kept separate?

Children are more likely to keep their toys in order if they have a well-designed cupboard for their exclusive use. Where two children must share a room, why not install or build double-deck beds?

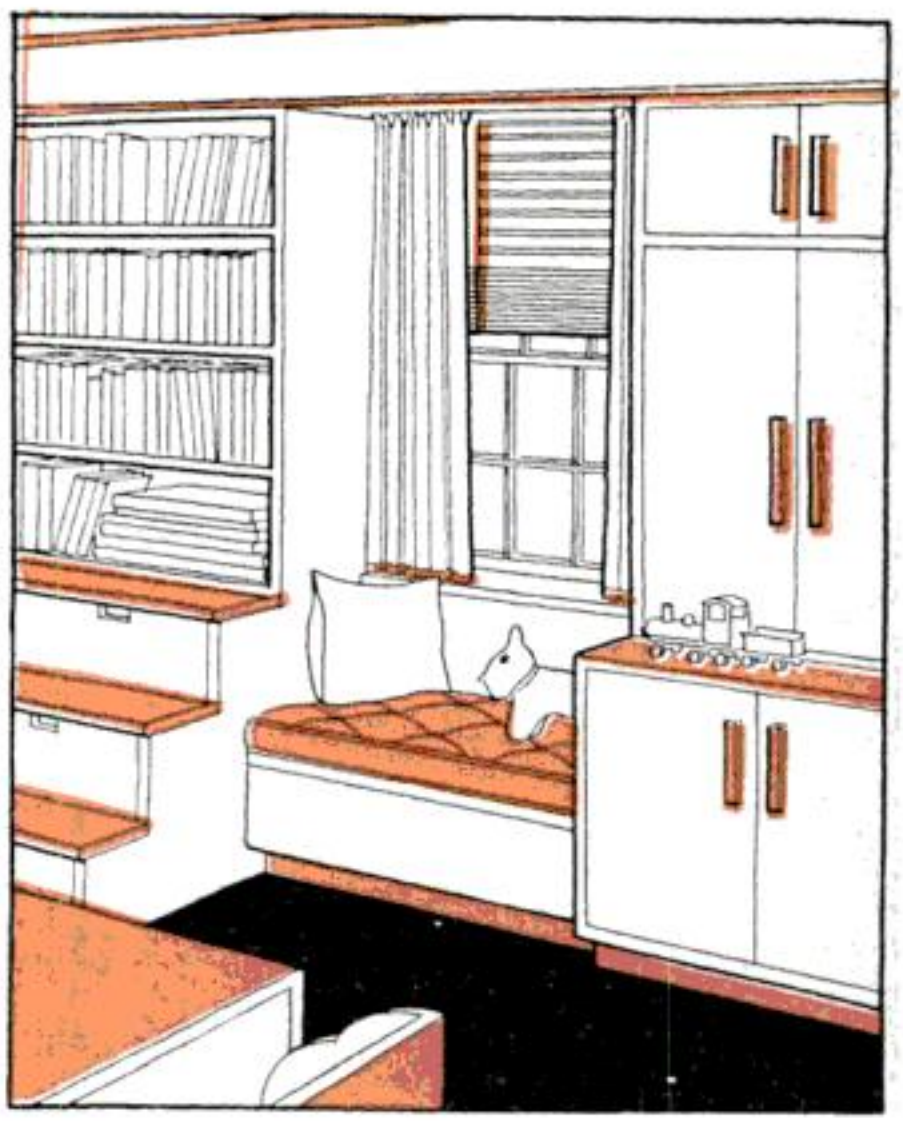
Full use of the attic depends in part upon good stairs to make it readily accessible. There are available disappearing stairways that can be installed in trapdoor spaces as small as 2′ 2″ by 4′ 0″ where room is limited.

For summer comfort, adequate ventilation in the attic is a necessity. A fan to provide circulation there, and another for the kitchen, are wise investments.

Don't overlook the possibility of building a mothproof closet in the attic for storage of heavy winter clothing, overcoats, and blankets. When they are removed for use, summer suits, draperies, and other warm-weather articles can be stored in their place.

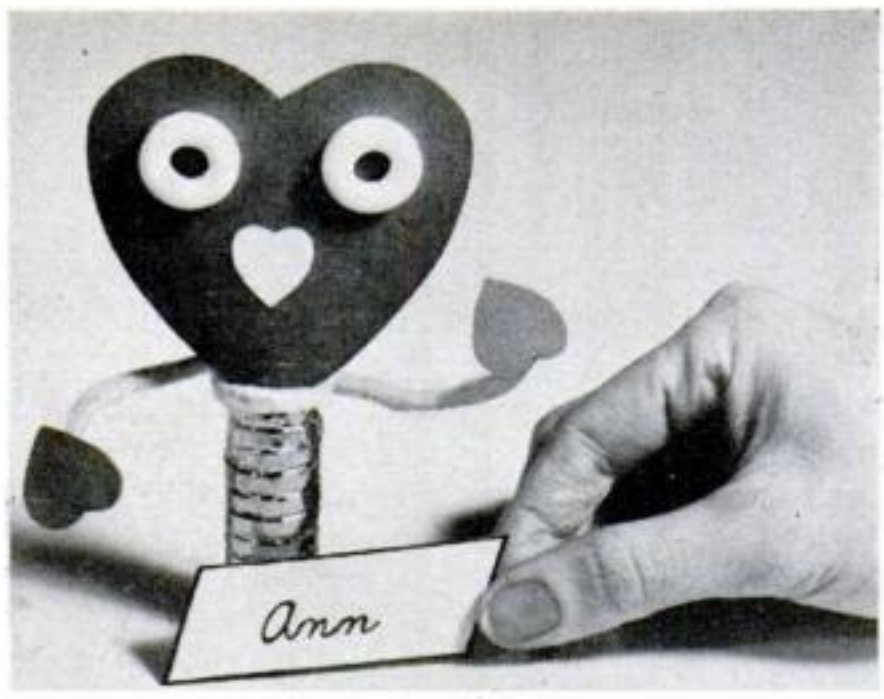
On the outside, be sure first of all to keep your house well painted. Consider the addition of a terrace or a porch. Perhaps your old awnings need new canvas, or extra awnings are necessary. You may wish to install an overhead garage door, or fasten together the old doors as an overhead unit.

Such improvements as these are a sound long-term investment. Careful planning and wise purchasing now will pay dividends of satisfaction through years to come.



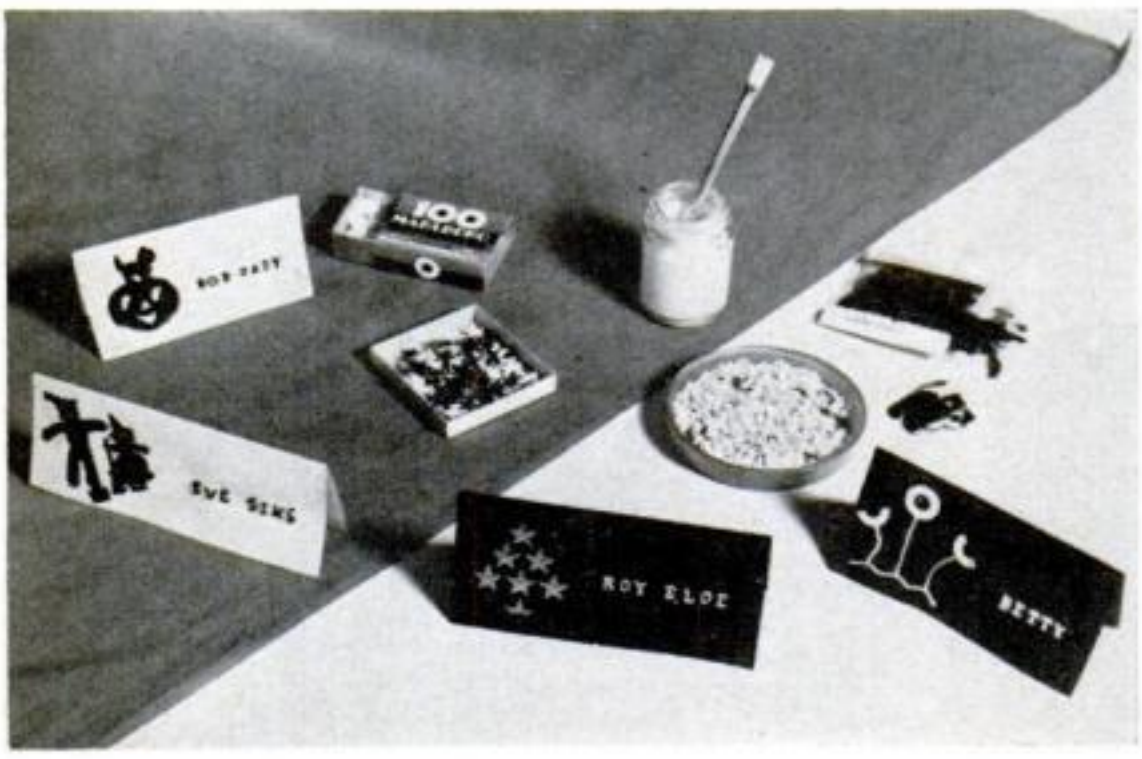
Children will learn orderliness if you make it a practical virtue by providing bookshelves and toy cabinets. The treads of the bookshelf steps above are hinged, and toys can be stored inside them

Place Cards



The arms are pipe cleaners, with candy-heart hands

FOR VALENTINE PARTIES, you can make amusing place-card favors from rolls of candy mint rings. Remove the paper, but not the tin foil. Cut the head from red paper, glue on mints for eyes, a candy heart for the mouth, and cement to the mint roll. The head might also be a heart-shaped cookie with eyes and mouth baked on, held with a skewer thrust through the roll of mints.



TO MAKE YOUR PARTY "different," why not design your own place cards? A bag of alphabet-soup macaroni will provide all the letters you need for the names. They may be colored beforehand to suit any decorating scheme, and can be used in combination with sketches, paper cut-outs, stars, decalcomania transfers, and even gummed notebook reënforcements to create novel, original designs. Such letters give a pleasing three-dimensional effect.

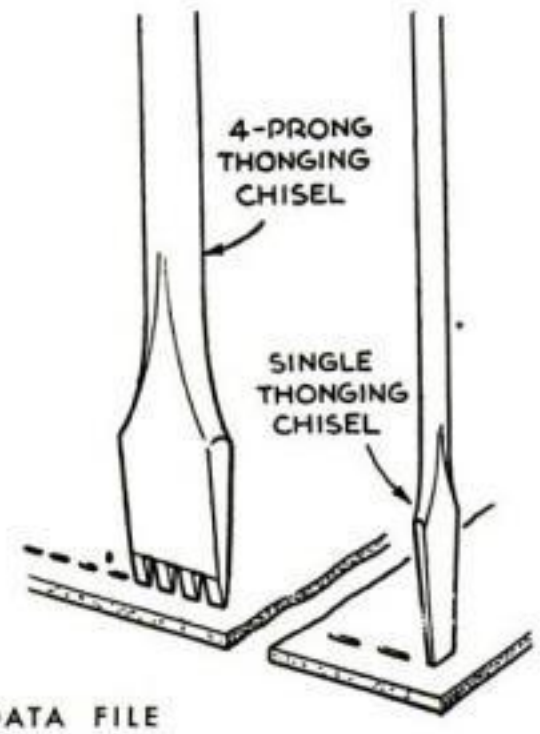
CEMENTING, THONGING, SEWING

[*LEATHER CRAFT—8*]

Complete all tooling operations and let leather dry before cementing. Skive edges to be cemented (Leather Craft–3). Apply rubber cement to both edges ⅛" back and allow to dry. Apply thin second coat; then press edges together. Tap cemented edges lightly with hammer.

Edges to be laced must be trimmed and corners rounded after cementing is completed. On finished side, lay out a light pencil line ⅛" from edge. Place flesh side of leather on board. Hold four-pronged thonging chisel along pencil line at right angles to leather. Strike sharply with mallet, cutting through. Place first prong of chisel in last slit of previous cut to space correctly. Use single punch at corners.

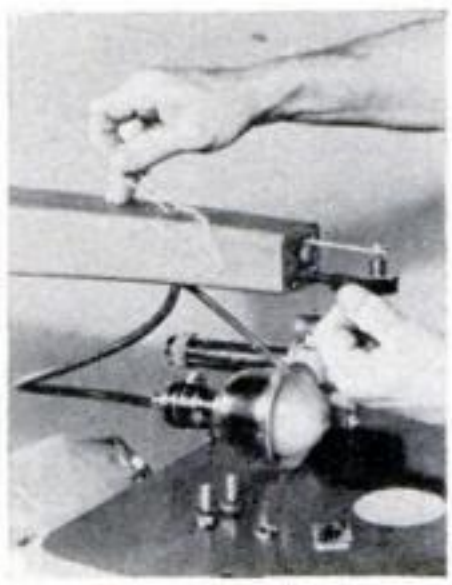
Leather to be sewed must first be cemented. Use heavy silk or linen thread on ordinary sewing machine. Place paper between feed-dog and leather to protect finished side.

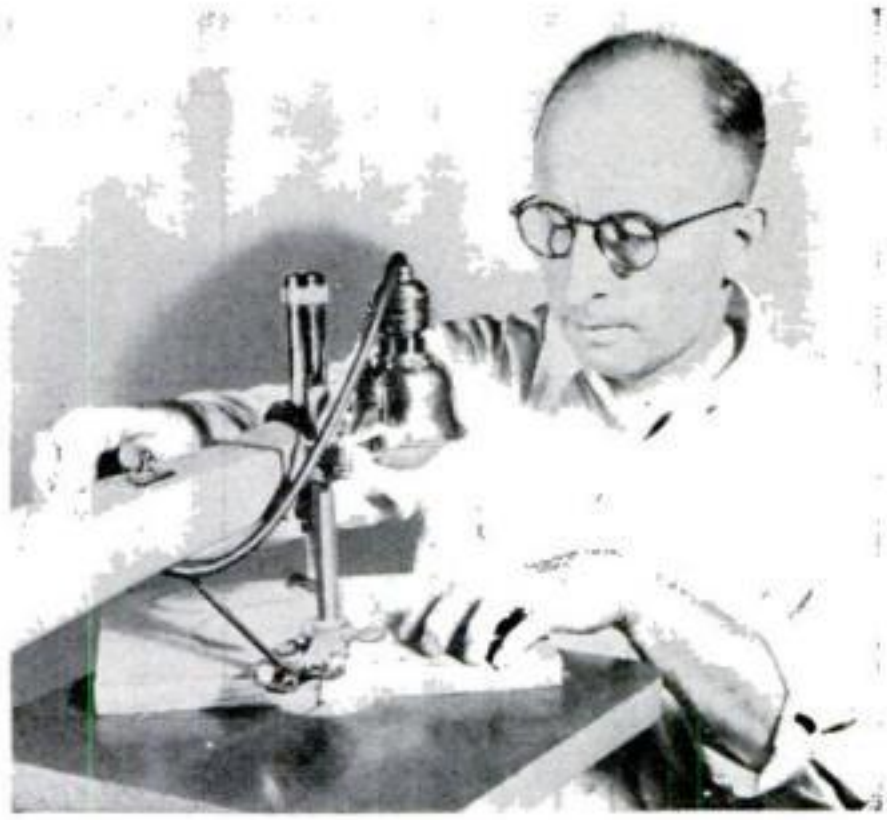


POPULAR SCIENCE MONTHLY SHOP DATA FILE

Switch Fastened on Top of Scroll Saw for Convenience

A GREAT convenience for scroll-saw workers is an on-off switch installed on the arm of the machine as shown. The switch, stocked by radio houses, is of the toggle type and rates 125 volts, 3 amperes. For the kind of machine shown, the overall measurements of the switch should not exceed 1¼" long, 1⅜" high, and ½" thick. To aid in installing it, drill a ½" hole in top of the arm directly above the present hole. Connect the switch in the usual manner to the motor cord, using rubber-covered, two-stranded wire.—FRANK HEGEMEYER.

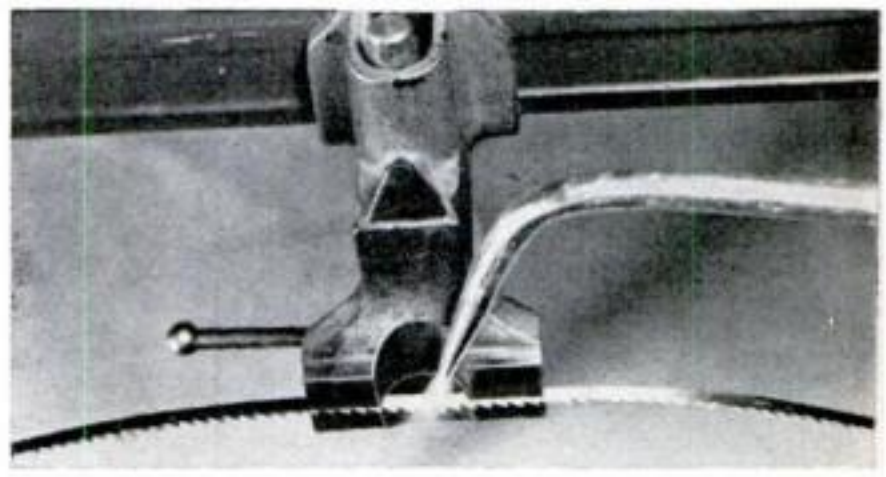




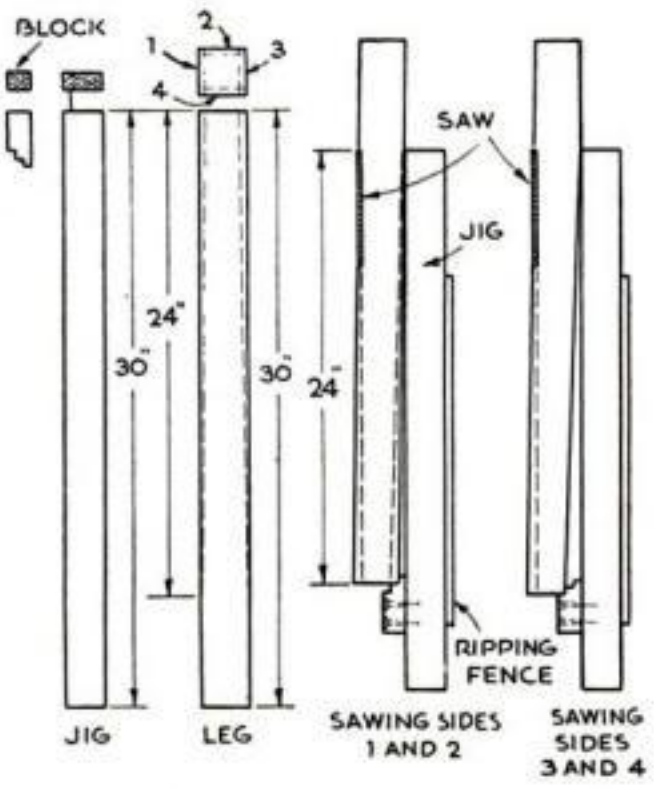
Connections made, the switch is put into the saw arm, a cord helping to guide the toggle to the top

Vise Used to Clamp Band-Saw Blades in Position for Brazing

AN INEXPENSIVE small vise is easily converted into a clamp to hold band-saw blades in alignment for brazing. All that is necessary is to cut a semicircular notch in the middle of both jaws, as shown. A cutting torch can be used for this, or the notch can be ground, filed, or sawed. A good-quality hack-saw blade of the flexible-back type can be used to saw along the curve if it is narrowed by cutting off the back with tin snips. Mount vise with handle downward.



TAPERING TABLE LEGS ON CIRCULAR SAW [*WOODWORKING*]



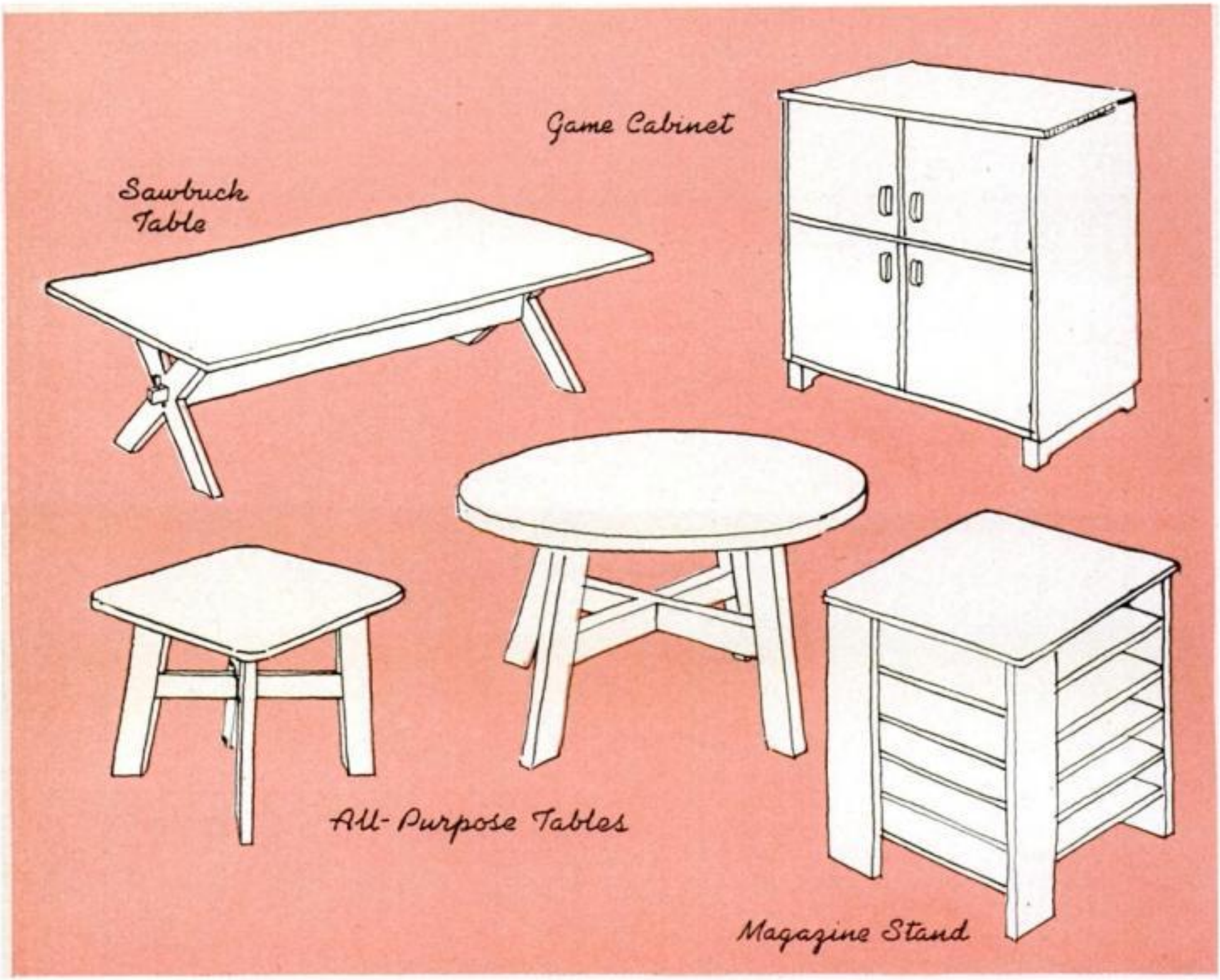
1. Make a jig from a board 2" by 30" and a block 1" by 3". Cut two steps or notches in the block equal to the width of the taper to be cut, for example ¼". Measure the length of the taper on the jig and nail the block to it at that point.

2. Place the leg to be tapered in the first notch and measure the combined width of leg and jig. Set the ripping fence to this distance less the amount of the taper. (It is well to gauge the taper on the end of the leg in order to set the ripping fence accurately.)

3. Hold the leg firmly in the notch and saw the taper on two adjoining sides.

4. Cut the taper on the other two sides by placing the already tapered sides of the leg in the second notch of the block.

POPULAR SCIENCE MONTHLY SHOP DATA FILE



More Recreation-Room

By JOSEPH ARONSON

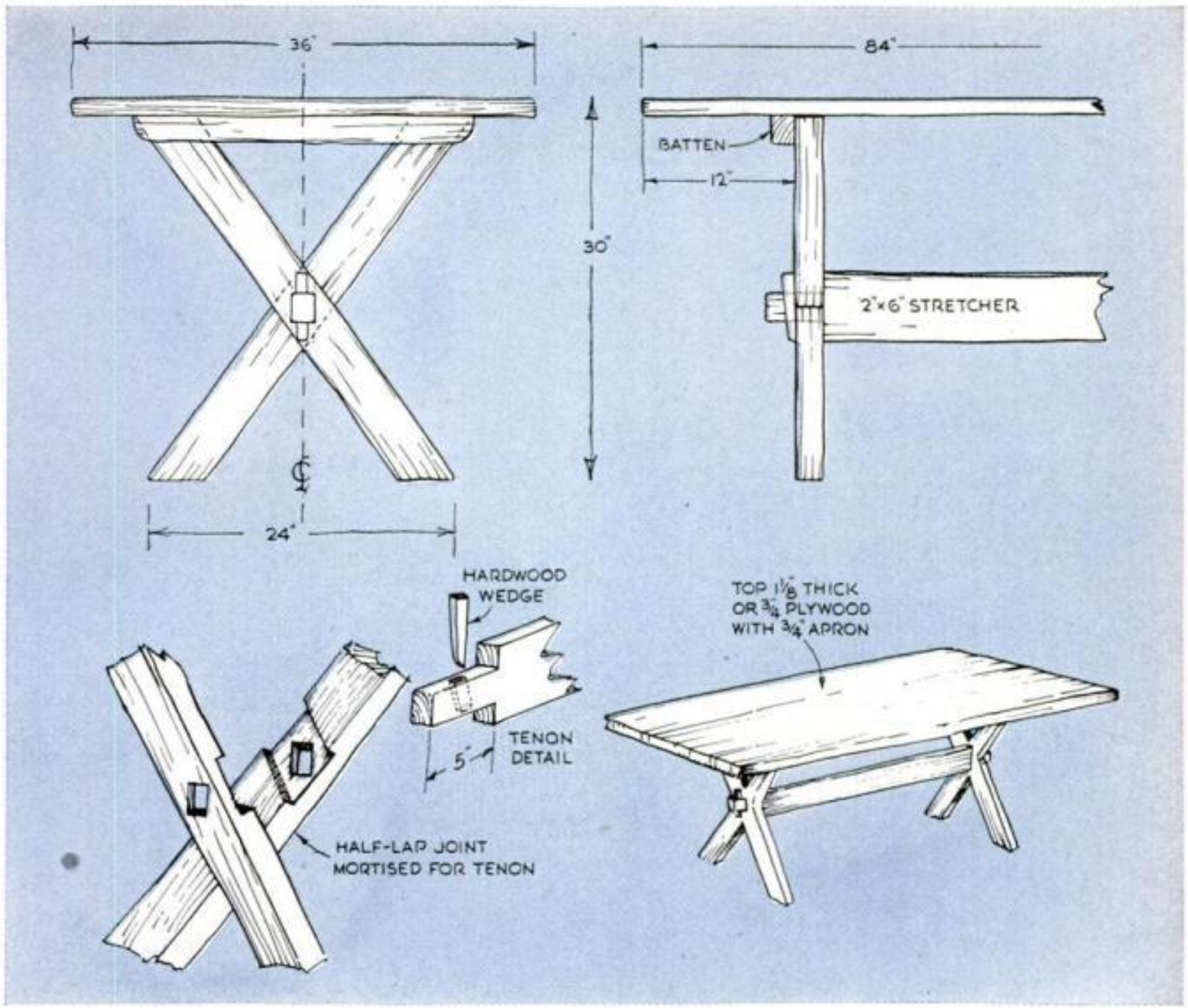
THE popularity of any recreation center or game room will depend in large measure upon the provision of comfortable seats and tables for all. Convenient storage space for games and magazines is also important. To meet these needs, several simple furniture designs were suggested in the preceding issue (P. S. M., Jan. '42, p. 162), and these are supplemented this month by plans for two substantial tables, a roomy game cabinet, and a four-sided magazine rack.

All parts are stock lumber, obtainable anywhere. The pieces can be built with hand tools by anyone having average skill in carpentry and, aside from Army use, may solve the problem of a bare porch, an unfurnished basement game room, or an empty garden arbor.

Sawbuck table. This familiar and serviceable type of table is also one of the easiest to build. The top can be of 1⅛" thick dressed boards screwed to three battens, or of ¾" plywood with aprons on four sides to make the edges appear thicker. Plane and sand the legs smooth, and mortise them at the half-lap joints for the stretcher tenons. To cut the mortise for the wedge, first drill a ¾" hole at a slight slant into the tenon, then chisel the outermost edge of the hole square. Be sure to use hardwood for the wedge, and round the lower end.

For the 7′ long table suggested, the top should overhang 12" at each end. A 16" overhang is preferable for an 8′ table. In this and larger sizes it may be desirable to add two 2" by 3" stretchers lengthwise just under the top for greater rigidity. These could be nailed or screwed across the top inner edges of the legs.

Game cabinet. All sorts of game equipment, as well as other articles, can be stowed away in this roomy four-compart-



Furniture

DESIGNED FOR TRAINING CAMPS AND HOME USE

ment cabinet when table space is to be left clear. Three compartments are fitted with adjustable shelves. The fourth has vertical partitions to hold a variety of flat game boards.

The chief material used is ¾" plywood. Let the top overhang the sides and front by ½". Cut the plywood back ¼" short to avoid showing splintery edge grain at the rear edges. Fit the ½" thick plywood partitions loosely between strips of quarter-round molding. Hinge the doors with narrow 2" by 3" cabinet butts, and fit them with cupboard catches.

The two base members are shaped as indicated from ordinary 2" by 4" stock.

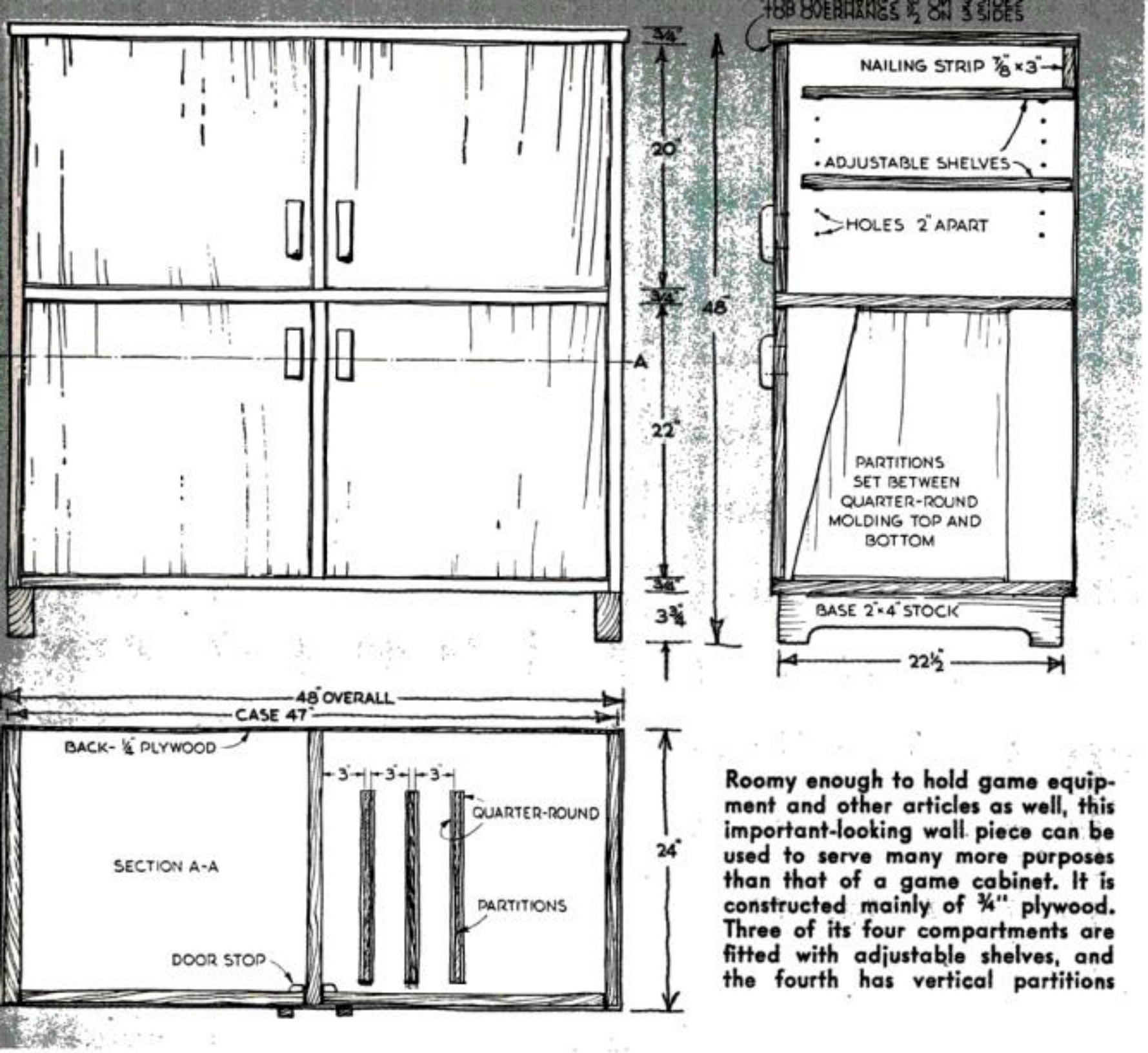
Round all-purpose table. There's always room for one more at a round table, and the kind illustrated will prove a favorite for games, get-togethers, and general use. The top can, of course, be made octagonal or even square if some such shape is preferred. Two sizes are suggested in the accompanying drawings.

Make the framework first, using 2" by 4" stock for the legs and aprons. Cut the inner edge of the legs square at the top to butt firmly against the braces, which are screwed to both the other members. Dowel or screw the aprons to the legs. The stretchers may be of 2" by 3" stock, and should be joined to

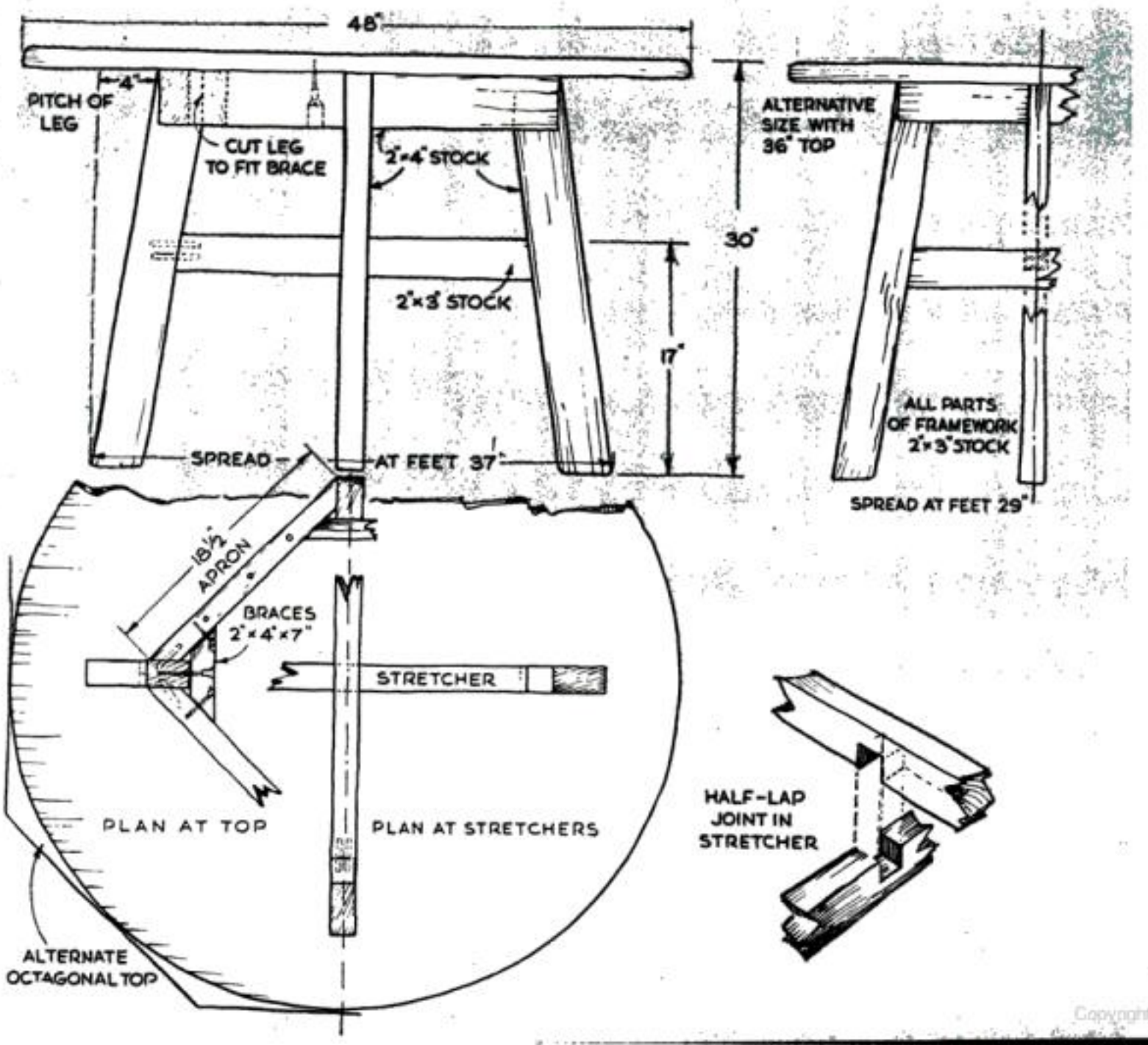
MATERIALS FOR SAWBUCK TABLE

No. Pc.	Description	Dimensions
1	Top	1⅛ by 36 by 84
3	Battens	2 by 2 stock, 26½ long
4	Legs	2 " 4 " 38 "
1	Stretcher	2 " 6 " 66½ "
2	Wedges (hardwood)	¾ by 1¼ by 6

NOTE: All dimensions are given in inches.



Roomy enough to hold game equipment and other articles as well, this important-looking wall piece can be used to serve many more purposes than that of a game cabinet. It is constructed mainly of ¾" plywood. Three of its four compartments are fitted with adjustable shelves, and the fourth has vertical partitions

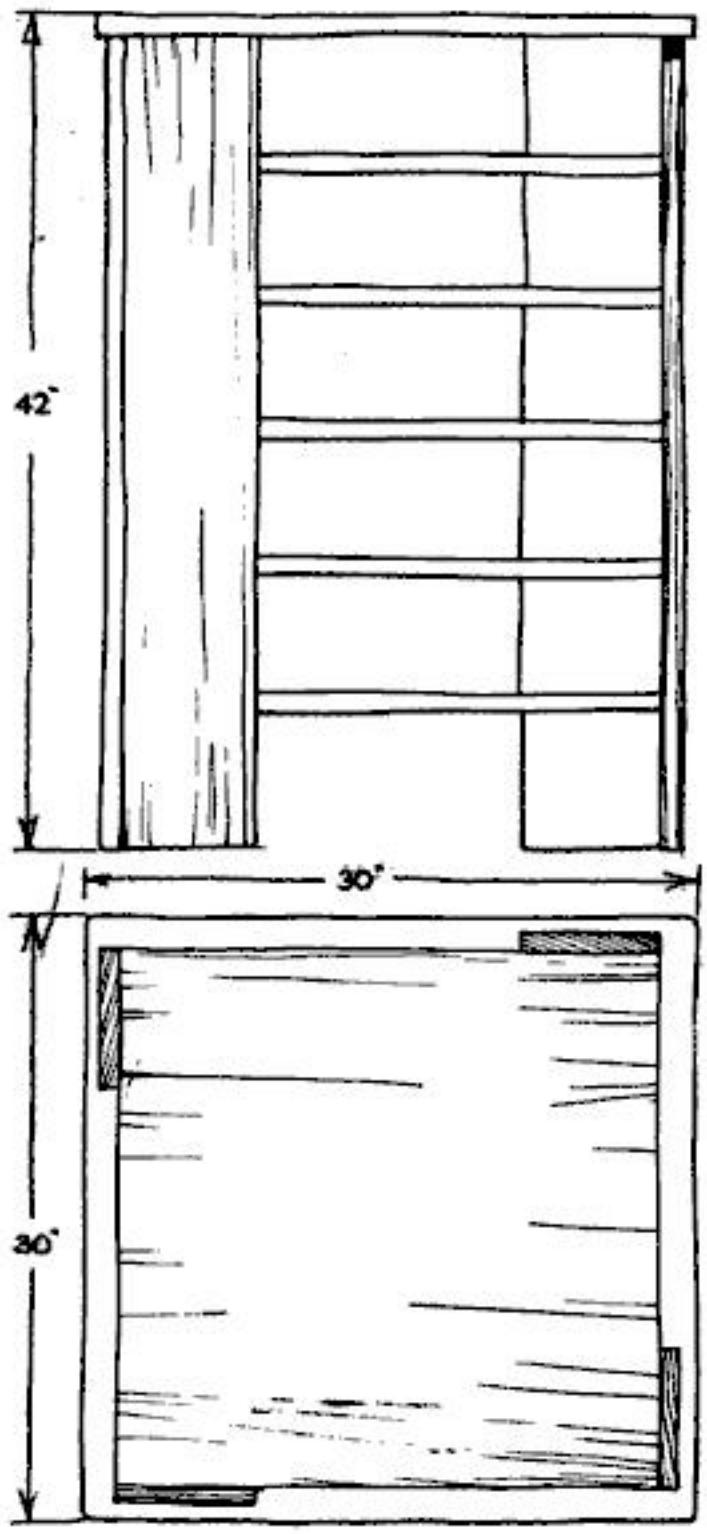


MATERIALS FOR GAME CABINET

No. Pc.	Description	T.	W.	L.
1	Top (plywood)	¾	24	48
2	Sides "	¾	23¼	43½
2	Floors "	¾	23¼	45½
1	Upright, upper (plywood)	¾	20	23¼
1	Upright, lower "	¾	22	23¼
2	Doors, upper "	¾	20	22⅜
2	Doors, lower "	¾	22	22⅜
6	Shelves "	¾	22	22¼
3	Partitions "	½	17	22
1	Back "	¼	43½	46¾
1	Nailing strip	⅞	3	45½
4	Handles	⅞	1⅛	4
2	Bases	1¾	3¾	22½

Miscellaneous: 8′ quarter-round molding, 8 cabinet hinges, 4 cupboard catches, 24 shelf pins, nails and screws.

NOTE: All dimensions are given in inches and are finished sizes.



the legs with ¾" dowels to insure the required strength.

Drill and countersink at least three holes in each apron for the screws that fasten on the top. This should be glued up from 1⅛" boards. If the table is to be used outdoors, make the joints with one of the new plastic resin glues.

Magazine stand. Periodicals kept on the shelves of this stand are accessible from all four sides. Although dowel joints are to be preferred, the design lends itself to nailed construction, and will make a sturdy, useful piece. The shelves should be evenly spaced. It would be possible to convert this into a four-sided bookcase by altering the dimensions to 18" by 18" by 48" and spacing the shelves somewhat farther apart as required for books.

Finishing. Some of the time saved by using stock lumber and nailed or screwed joints may well be spent in carefully rounding and smoothing all edges and surfaces with plane and sandpaper. Unevenness in grain and color can best be concealed by staining the wood a medium brown. For a waxed finish, apply two thin coats of shellac, sand them smooth, and finish with paste or automobile wax. For outdoor use, apply two coats of high-grade waterproof spar varnish instead of shellac.

Quickly applied and very durable is the one-coat finish obtained by using wood preservative. This material is sometimes called "penetrating floor finish" or "floor seal." Allow it to dry fully, rub with steel wool to an even satin smoothness, and wax.

MATERIALS FOR MAGAZINE STAND

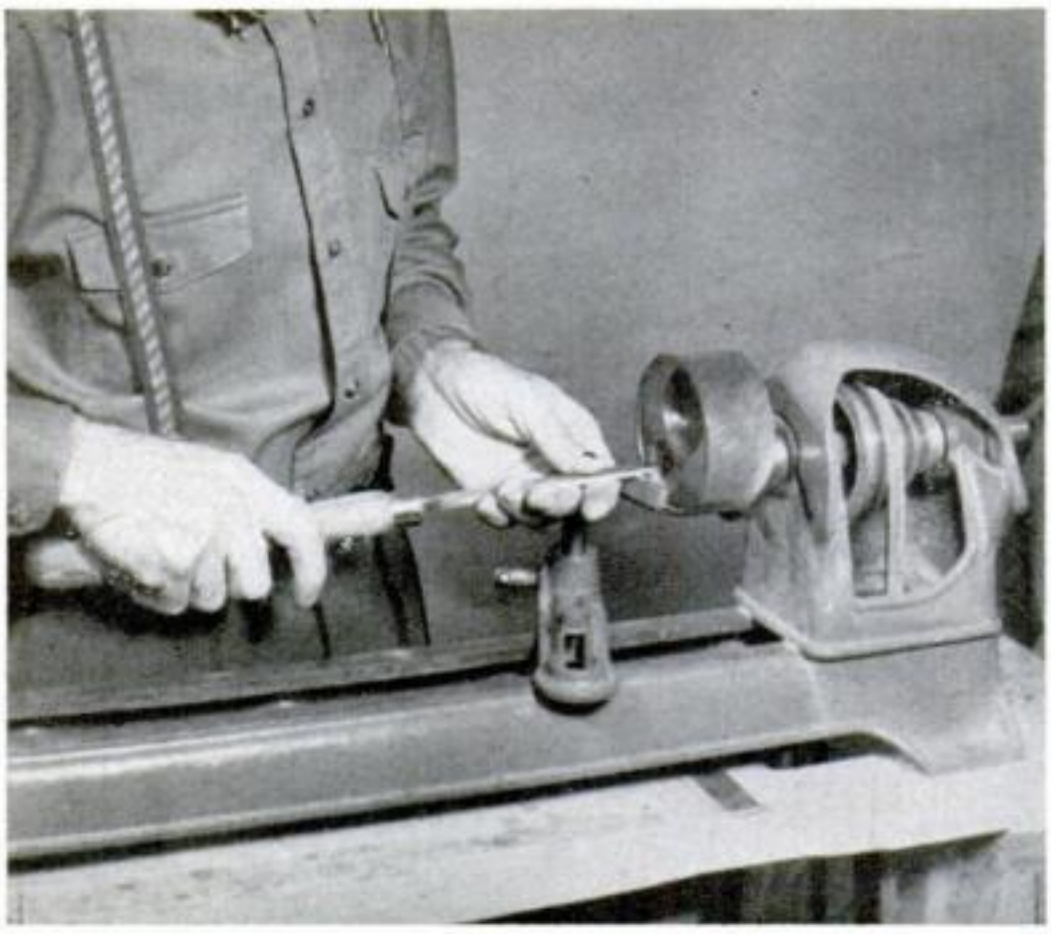
No. Pc.	Description	T.	W.	L.
1	Top (plywood)	¾	30	30
5	Shelves (plywood)	¾	27	27
4	Uprights "	¾	7	41¼

NOTE: All dimensions are given in inches and are finished sizes.

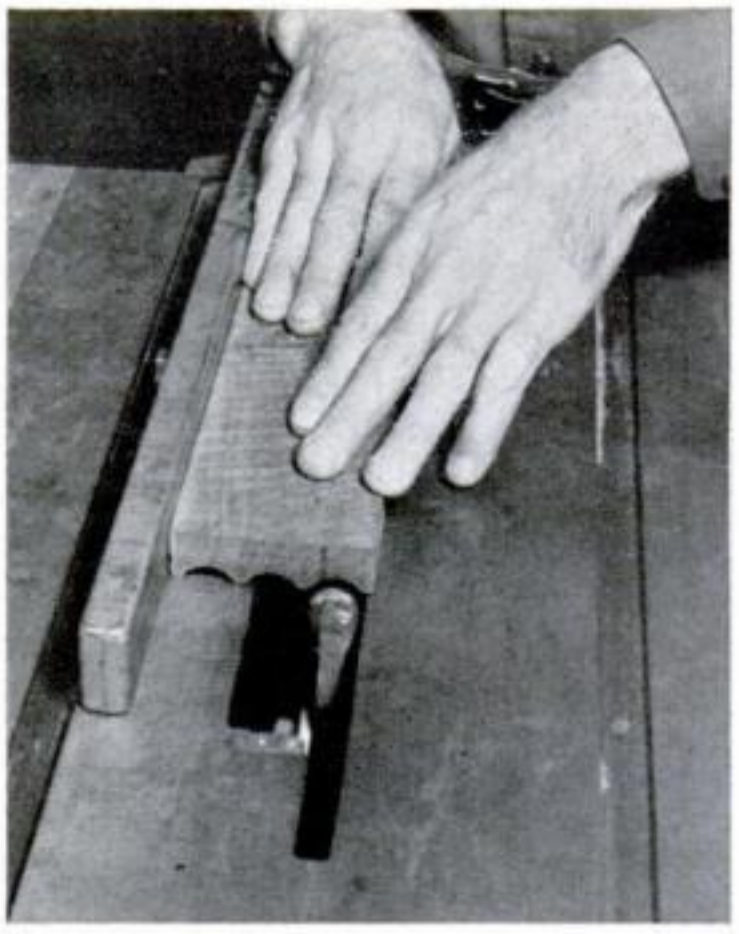
MATERIALS FOR ALL-PURPOSE TABLE

No. Pc.	Description	Dimensions
1	Top	1⅛ by 48 by 48
4	Legs	2 by 4 stock, 29½ long
4	Aprons	2 " 4 " 18½ "
4	Corner braces	2 " 4 " 7 "
2	Stretchers	2 " 3 " 25½ "

NOTE: All dimensions are given in inches.



With the work mounted off center, two wells are turned in one of the endpieces as above. The other endpiece has one well

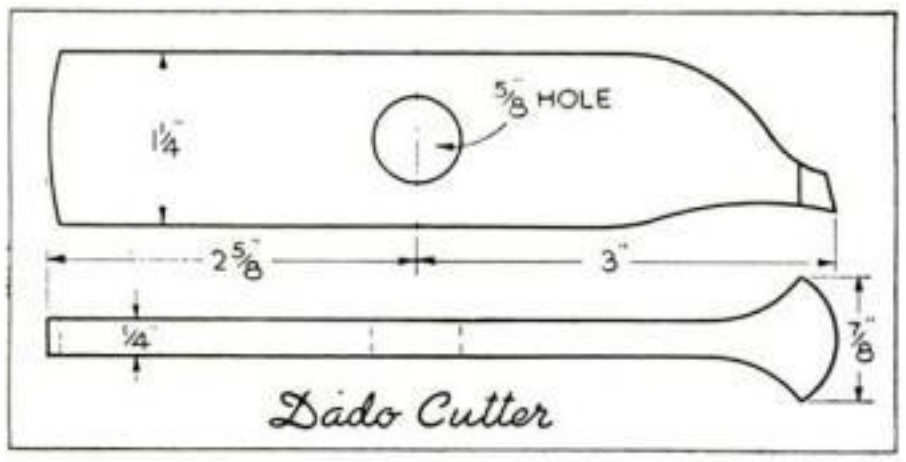


The grooves may be cut in various ways. Here a special grooving cutter is used

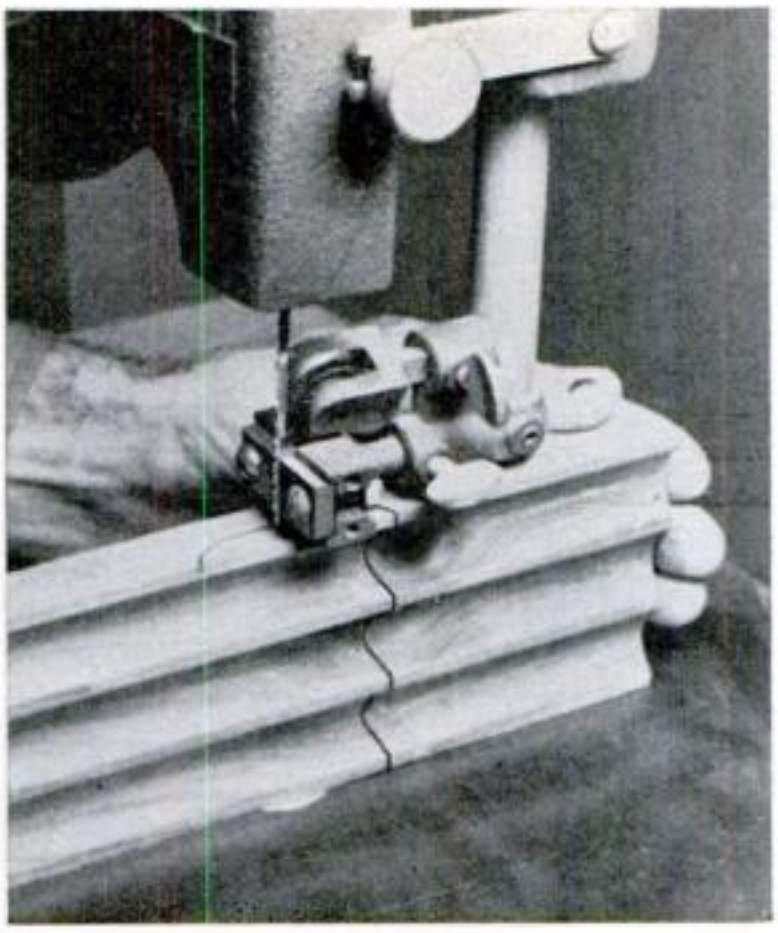
Modern Desk Tray

NICELY grained stock left over from larger projects can be used to advantage in making this rich-looking desk accessory. The work involves some interesting off-center turning.

Walnut was used for the original shown in the photographs. Both endpieces are turned from 2" thick stock. Mount a 4⅛" disk on the faceplate, turn it to 4", and turn out the inside 1⅜" deep. Sand thoroughly and apply shellac in the lathe. Then, at low speed, hold against the work a cloth dampened with alcohol. With a parting tool cut off the piece to a thickness of 1½".



This is the tool, resembling a dado cutter, that Mr. Nielsen made for grooving the rack. Left, two 5/16" dowels fasten the rack to each endpiece



Band-sawing a ⅜" depression in the center of the rack. A hand coping saw could be used

The other endpiece has two turned hollows. Mount the stock and turn a 1/16" deep rabbet out to a diameter of 3⅝". Turn to size outside and finish with shellac as described. Then remount the piece on the faceplate 13/16" off center, and turn and finish the larger well. In remounting it to turn the smaller well, be sure that its center and that of the other one lie on the same diameter of the piece.

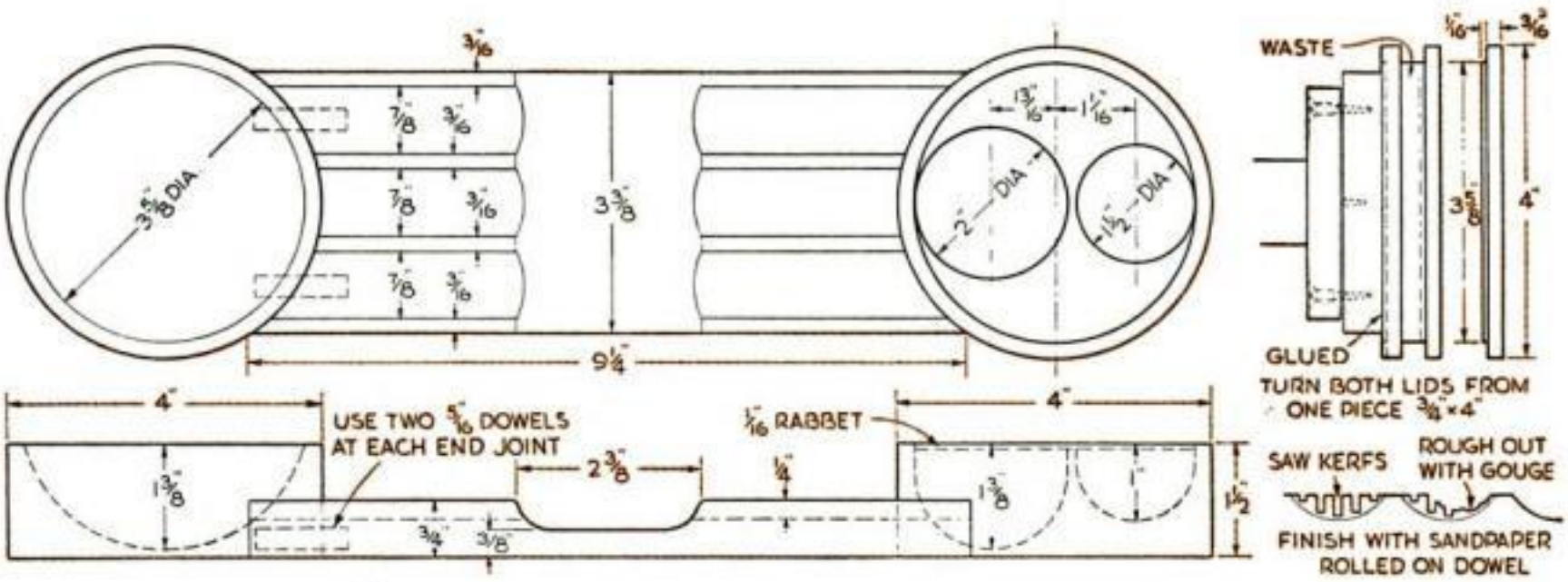
Turn the lids from a single piece of ¾" stock so that their grain will match. The shoulders should fit the rabbets in the endpieces freely but not loosely.

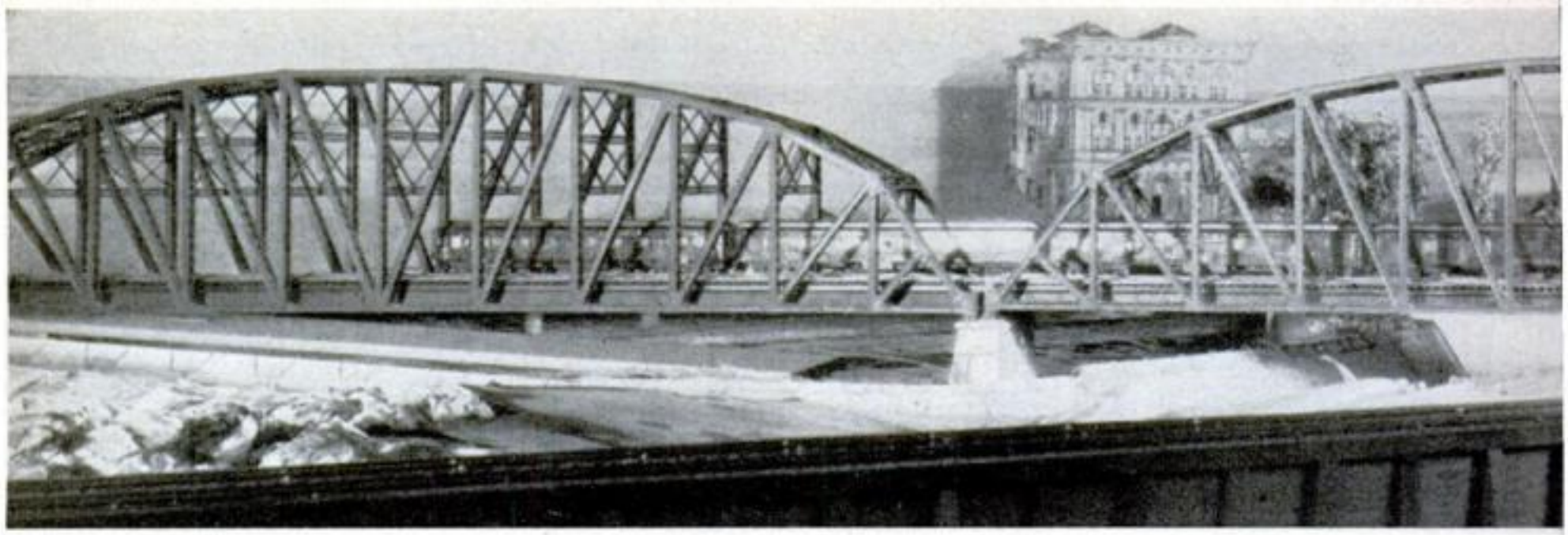
In making the pencil-rack part, you can form the grooves either by passing the work over the circular saw to form cuts of various depths, and removing the waste with a gouge and sandpaper, or, if a number of trays are to be made, by using a special grooving cutter in the circular saw as shown in one of the photographs. Such a cutter can be forged by any blacksmith at a nominal cost. If possible, keep the saw guard in place when running the work over the cutter.

Fit two 5/16" dowels at each end to join this part to the endpieces, finish the rack with three coats of shellac, and glue the three pieces together.—BENJAMIN NIELSEN.

Modern efficiency, as well as good looks, is a feature of this desk appointment made from scraps of hardwood

Drawings of the desk tray. At right, turning the lids; below that, another way to shape the grooves





Model Railway Layouts:

By DAVID MARSHALL

ON THE "grown-up" railroads all track is divided into two classes—main line and yard. And the difference can be summed up in the assertion that the laws of the road do not apply to yards. But the difference is also physical. Yard trackage must be kept separate from the main line; insulated from it by switches that nobody may open except on orders from the dispatcher. For the moment, however, it is enough to note that a main line and a yard are so very different that neither can form a part of the other.

But yards are easily designed, and quite as easily incorporated into any kind of model-railway layout. (We shall hear about them later.) The biggest problem in the whole field of model railroading is how to lay out a main line (1) that will fit within the space you have available, (2) that will provide for as many train maneuvers as possible, and (3) that will conform, as far as it goes, to all the operating standards of the grown-up railroads.

THE MAIN LINE. This baffling problem becomes rather simple when you realize that there are, after all, only three kinds of main line (Fig. 1). The first and foremost of these is the *continuous line* (*A*) which has no terminal. The second is the *point-to-point line* (*B*), which has a terminal at either end. And the third type (*C*), with a terminal at one end and a reversing loop at the other, is what we call *out-and-home line.* As there is no fourth, you take any one of these three—figuratively, you take it and curl it about to fit your space. Actually, of course, you begin with a scale drawing of your available site, and sketch it in, trying it various ways about. The rules are simple. You must contrive to

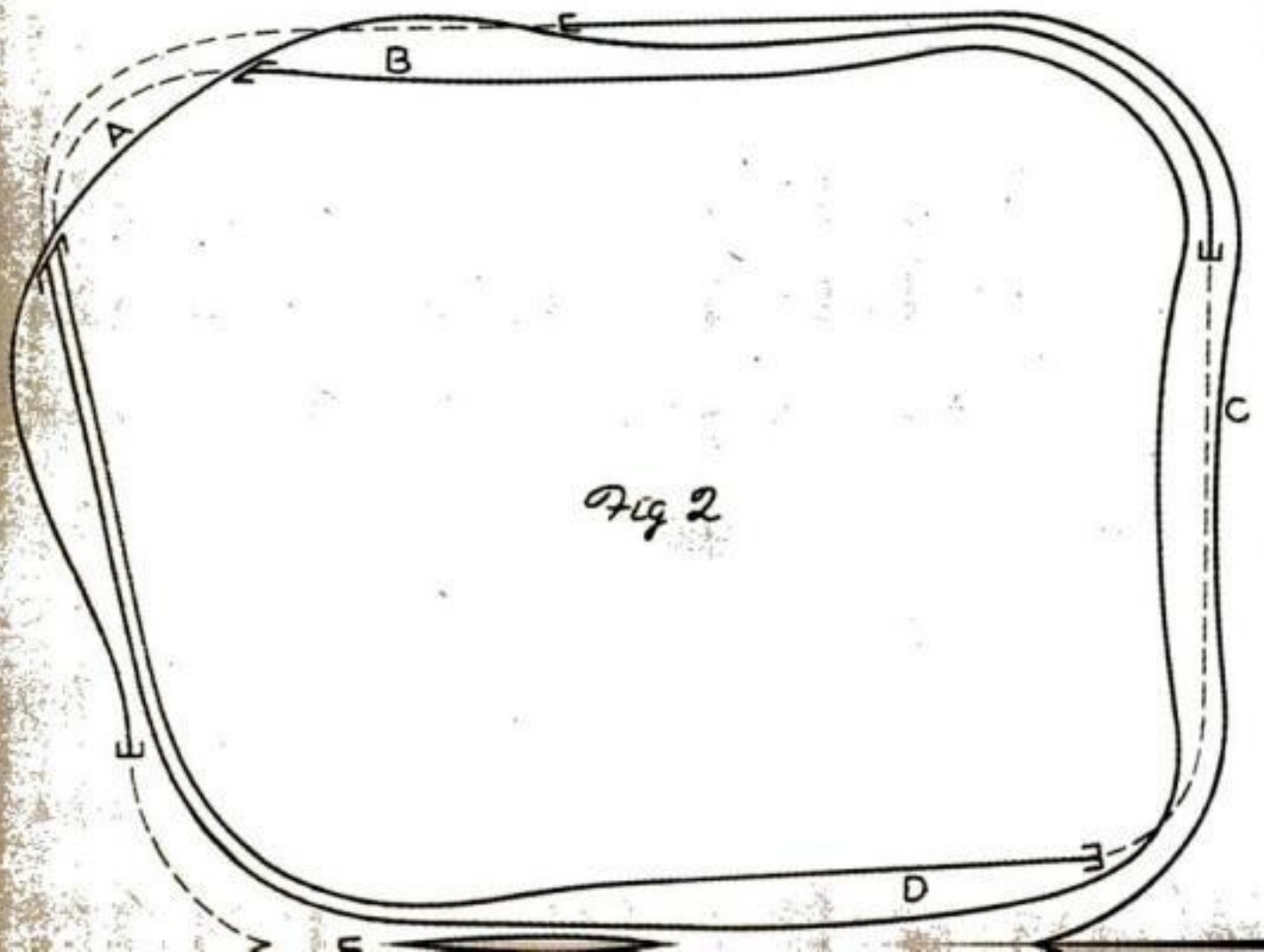


Fig 2

Providing great length of running space, yet taking up little room, the continuous line is the favorite of model railroaders. It allows use of straightaways, curves, and sneak-offs

The Main Line

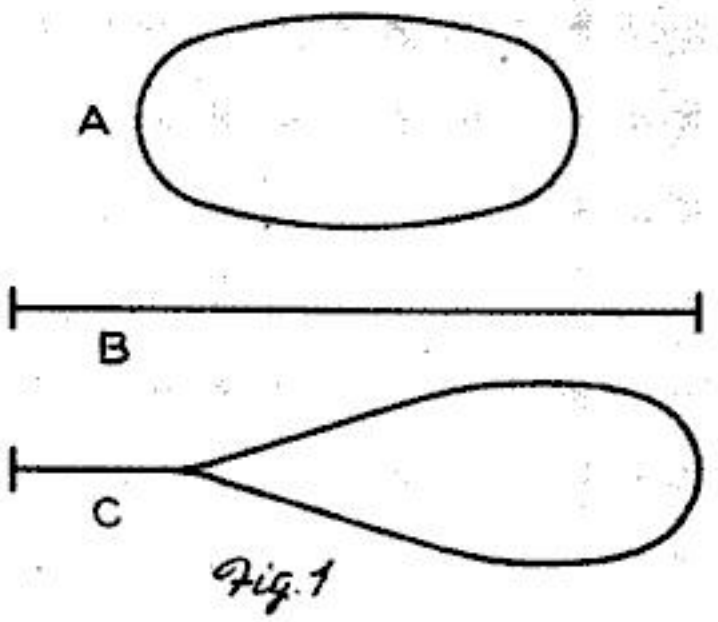


Fig. 1

One or more of these three types form a main line. At the Maywood, Ill., Suburban Club, the bridge adds color

get in the greatest possible length of line. And you must do this without crowding things, for too much track in too little space is the worst possible error. To conform to the standards of the National Model Railroad Association, your smallest curve must have a radius of 5′ for 0 gauge, 2′ 6″ for 00, and 2′ for HO.

CONTINUOUS LINE. This is the favorite of the best model railroaders of today. As in Fig. 2, it can wind three times around the four walls of a room before it completes itself. Thus it provides a very great length of running line, yet takes up a comparatively small part of the whole room. What's more important, it lends itself most easily to scenic development. It presents to the eye a narrow terrain which by contrast looks longer than it really is. And it makes possible the freest use of wide, swinging curves. In Fig. 2, *A*, *B*, *C*, and *D* are suggested station sites. It will be noticed that on the average a train leaving one station must run around three sides of the room before it reaches the next. Furthermore, *A* and *B* are so close together that they can well be made into a single structure—a kind of union station serving two different lines on two different levels. An important point, too, is that station *A* conceals the lower-level tracks that curl below it. Along the west (left) wall, it will be observed, these tracks approach the tunnel on undeniably straight lines—their straightness emphasized by the curl of the upper-level track. And that straightness we rely on to set up the very powerful suggestion that they continue straight beyond the mouth of the tunnel, and that the trains we see swallowed up in the gloom of the tunnel speed farther and farther away from us in that same straight line. Thus the concealed curves under *A* form a *sneak-off*, enabling a train that appears to be going one way to sneak around another way. Every good layout will have at least one sneak-off, and preferably two or three, because a layout must never look like a layout, and a model train must never be caught merely running round and round a loop. *(Continued)*

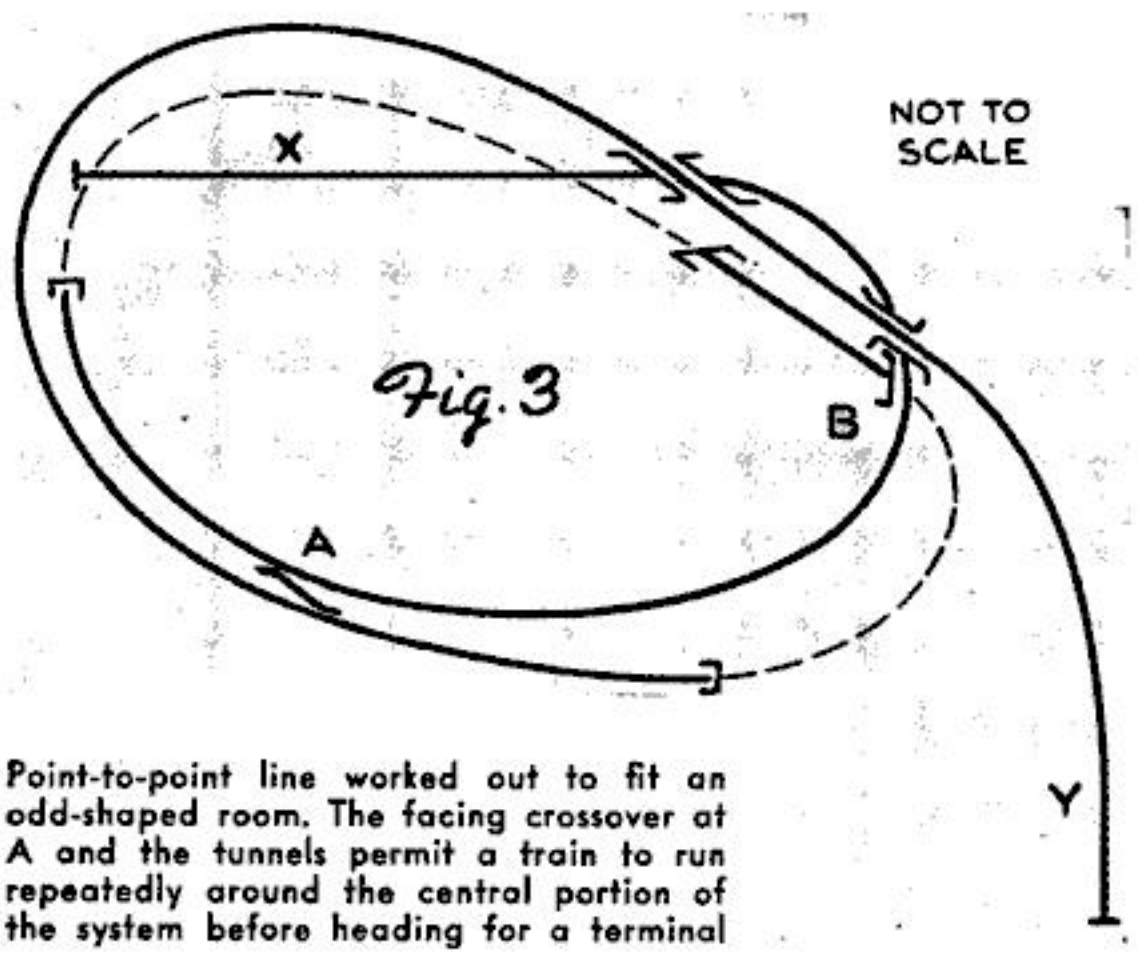


Fig. 3

Point-to-point line worked out to fit an odd-shaped room. The facing crossover at A and the tunnels permit a train to run repeatedly around the central portion of the system before heading for a terminal

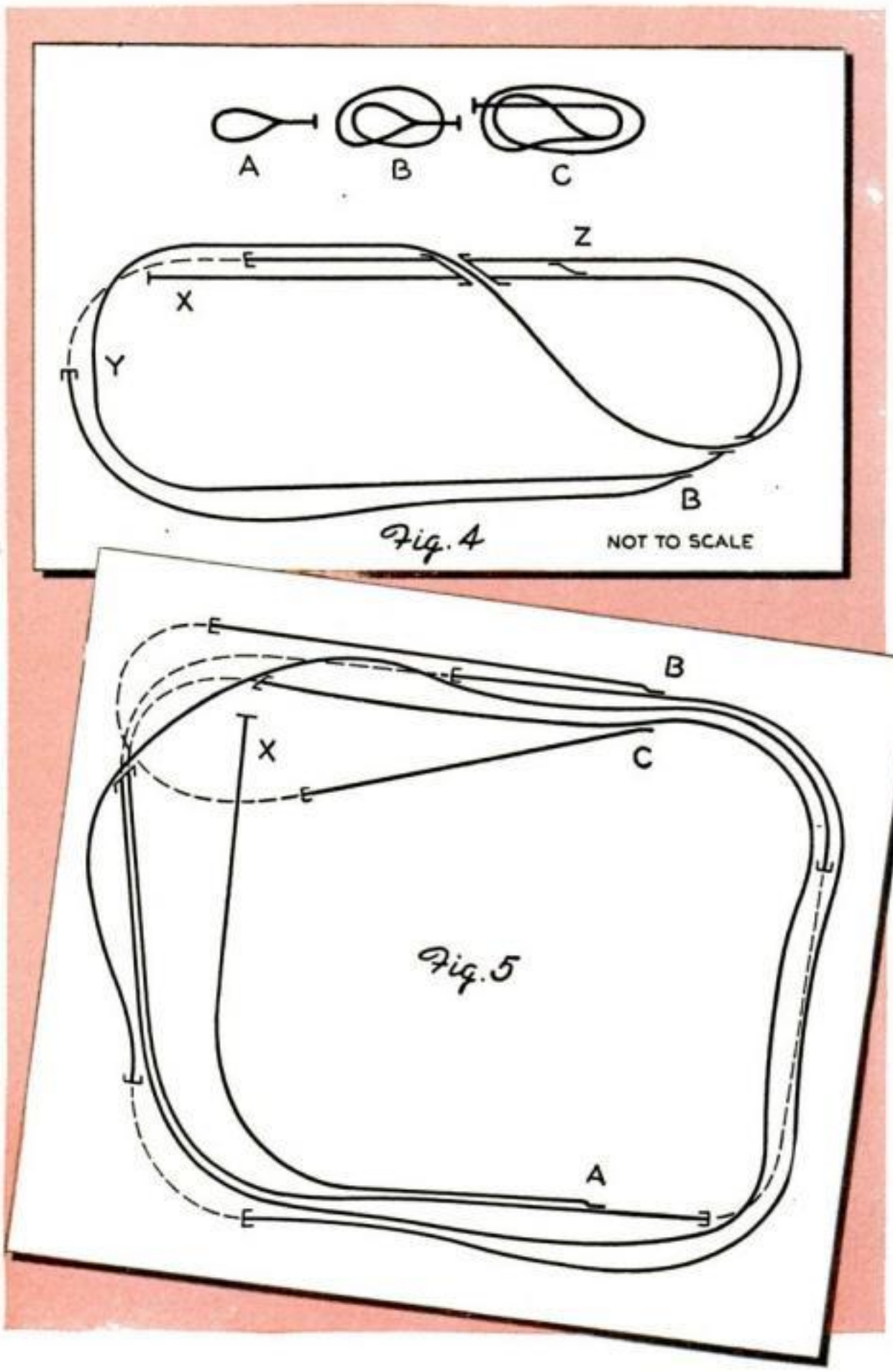


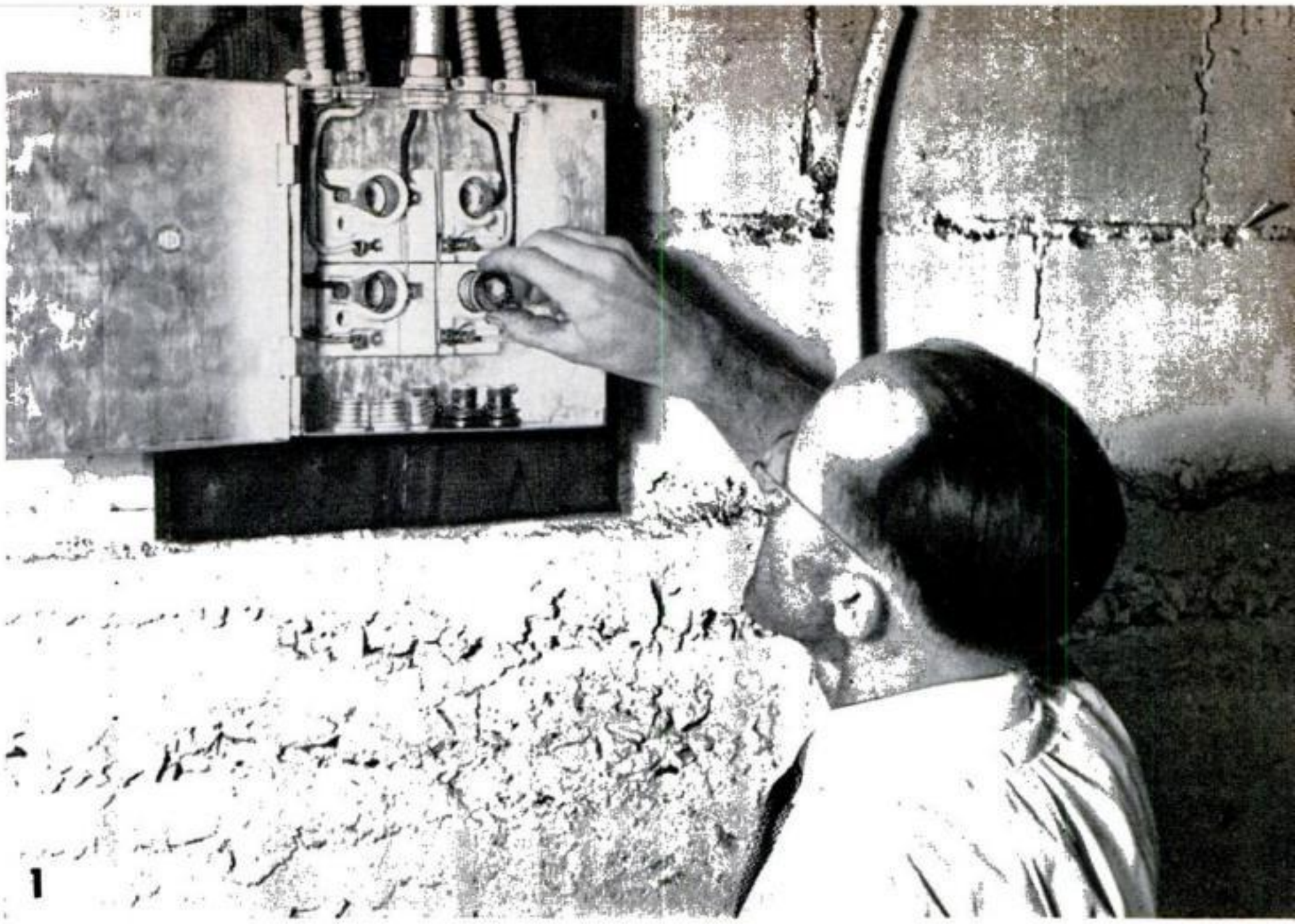
Fig. 4

Fig. 5

POINT-TO-POINT LINE. This is normally the meat of a very large club with no end of space, for a terminal can hardly be built in less than 900 scale feet, including platforms and switches—and this type requires two terminals. As in Fig. 3, however, it may be the only thing to fit within an odd-shaped room. The terminals are represented by *X* and *Y*, and from one of these to the other, the distance by rail is extremely short. This shortness of running line is a weakness inherent in all but the most extensive point-to-point lines. In the present instance it is cured, though not too well, by inserting the facing crossover at *A*, which enables a train from either terminal to move many times around the central portion of the system, thus piling up "repeat mileage," before continuing on to her destination. Sneak-offs, it will be noted, are not lacking here; and at *B* is a three-level crossing, which ought to make a fine engineering spectacle. Just south of *B*, perhaps, is a good site for a way-station—and stations, like all kinds of scenery, can be most valuable for what they conceal.

OUT-AND-HOME LINE. In Fig. 4 we have an exceptionally good example of this type of line; and at *A*, *B*, and *C* are illustrated the three main steps by which it was evolved. *X* is the terminal, and *Y* is a way station with elevated tracks; and these two structures between them form an excellent screen to prevent your getting from any one angle too full a view of the upper-level curve. But here again the lack of running line is particularly noticeable; and here again the facing crossover at *Z* creates the opportunity for repeat mileage.

COMBINATION LINE. In the case of the out-and-home line and the point-to-point line, we inserted that same facing crossover to give us badly needed running distance. But what we did in each case, as a matter of fact, was to tuck a continuous line into the midst of things; and so it follows, save in the most exceptional cases, that you cannot escape the continuous line. It's an excellent idea, therefore, to begin your model-railroading career by designing and building this type first, because it is best of all, confident that you will be able later on to transform it with a minimum of effort into a point-to-point line or an out-and-home line. In Fig. 5, for example, we have the continuous line of Fig. 2 transformed by simply cutting terminal *X* into the main line at *A* and cutting in a reversing loop at *B* and *C*. And if, instead of a loop, the switch at *B* had led to another terminal, we'd have had a point-to-point line. In this way, a combination line may be used to solve any special layout problem.



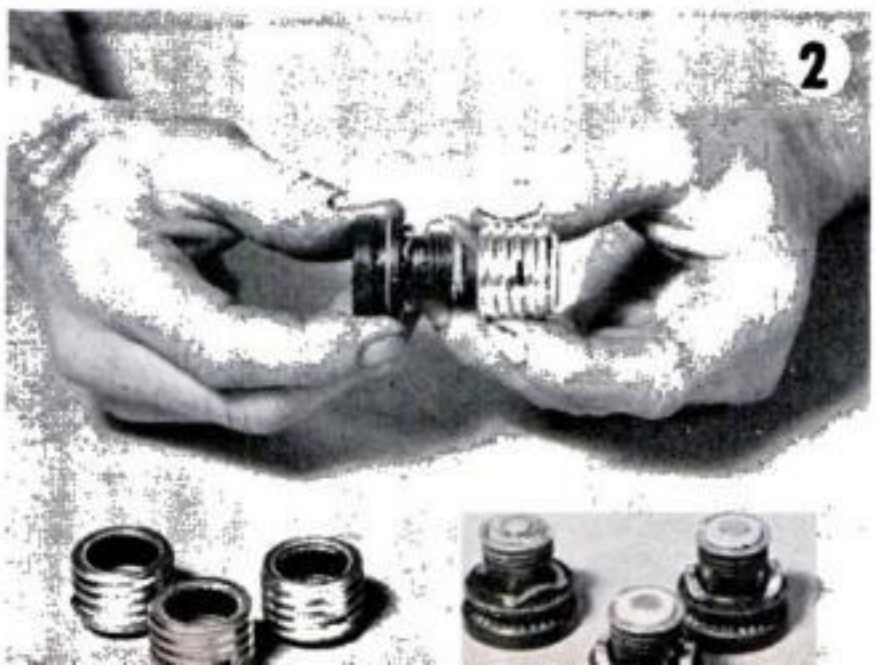
1

NEW TAMPERPROOF FUSES
Safeguard Your Home
AGAINST ELECTRICAL FIRE HAZARDS

By HAROLD P. STRAND

THOSE unknown experimenters who first discovered that a penny behind a blown fuse would restore electrical service paved the way for many fires that have resulted from overheated wiring. The tinfoil-patch and wired-plug user contributed their bit to the danger that lurks in all unprotected wiring circuits.

In today's electrically minded era, many persons realize the hazards involved in such "bootleg" devices, yet see no harm in using "stronger" fuses to avoid the annoyance of having a 15-ampere one blow when the home workshop lathe is switched on at the same time the refrigerator and electric iron are in operation. With circuits heavily loaded to keep oil burners, fans, washing machines, irons, radios, and other appliances working, the temptation to use 20- or 25-ampere fuses is greater today than ever



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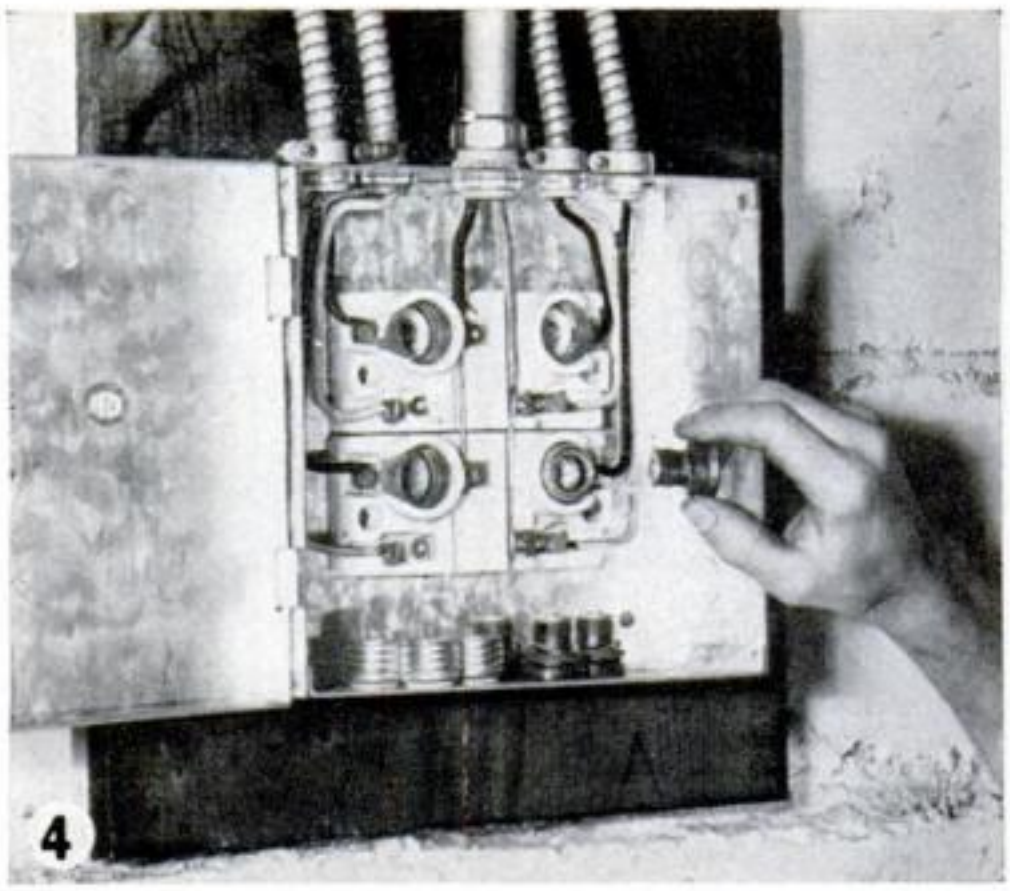
—and the fire hazard proportionately multiplied.

With this in mind, the National Board of Fire Underwriters has taken a decided step toward eliminating the hazard of overfusing. In the 1940 National Electrical Code, sections 2452 and 2453, will be found a ruling to the effect that after November 1, 1941, all fuses installed must be of type S, the nontamperable type. These will be used on all 125-volt service, 0 to 30 amperes.

The new fuses are made in a variety of sizes and in both the common fusible-strip type and the thermal time-lag variety. The latter are especially useful on circuits supplying motor-driven appliances, because the construction of the element is such that a short period of time elapses before the fuse will blow. This permits a motor to draw a heavy starting current for several seconds. On continued overload or short circuit, however, the fuse will blow out like any conventional one.

For the present, the standard Edison-type cut-out blocks will be used with the new fuses by installing adapters in the threaded sockets (Fig. 1). These adapters have a locking device which prevents their removal once they have been installed. The fuses are made in a variety of sizes, and their bases are so designed that fuses of 16- to 30-ampere capacity will not fit in the adapters installed for 0 to 15 amperes. In this way a circuit wired with No. 14 wire and originally intended to be protected with fuses no larger than 15 amperes will be assured of this protection for all time. It is impossible to place pennies back of these fuses. Installing jumper wires or other makeshifts is difficult if not impossible in most cases.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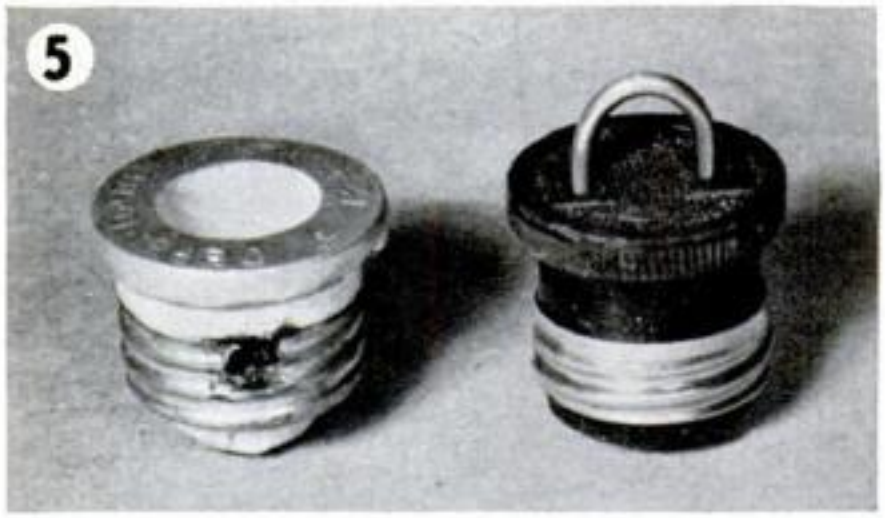
The code specifies two size ranges, namely 0 to 15 and 16 to 30 amperes, and it is possible to obtain fuses of capacities much less than 15 amperes. One group includes fuses rated at 3.5, 4, 4.5, 5, 5.6, and 6.25 amperes, as well as a special adapter for them that makes it impossible to use fuses of heavier rating. The 15-ampere adapter takes fuses of 7-, 8-, 9-, 10-, 12-, 14-, and 15-ampere capacity. In this way, installations that require low-capacity fuse protection can be made tamperproof to a large degree. There is even an adapter to fit only fuses rated at 1 ampere and less.

The installation of type S fuses in a circuit is simple. In Fig. 2 are shown several of the fuses and adapters of the 15-ampere size, together with an adapter being screwed on the end of a fuse. In Fig. 3, the adapter has been turned on all the way and it can be seen how the contact strips located under the fuse head now make contact with the rim of the adapter. The two units are then screwed into the cut-out socket together as in Fig. 1, and tightened to the right as far as possible. The fuse can then be easily removed (Fig. 4), but the adapter remains firmly locked in place by the spring-steel ratchet spur on its side.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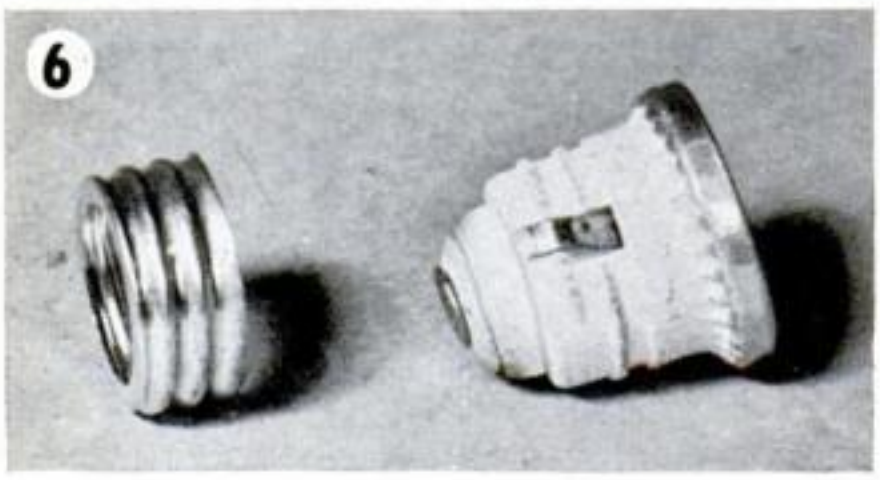
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The other illustrations on these pages show graphically a few of the reasons why the new code regulations require nontamperable fuses.

In Fig. 5, at the right, a substitute for a fuse is shown. It was placed in a circuit by a man who thought a 15-ampere fuse wasn't heavy enough because this size blew out frequently. The bootleg device consists

of an attachment-plug screw base with a U-shaped piece of No. 12 copper wire pushed into the slots. As cut-out bases have standard socket threads, this plug was easy to substitute for a fuse. The danger this innocent-looking makeshift involved is realized only when one considers that it takes about 235 amperes to melt No. 12 copper wire!

At the left in Fig. 5 is shown a cheap fuse bearing no Underwriters' label, such as is commonly sold in cut-rate stores and some hardware stores. Many of these are of foreign make. As can be seen in the photo, the blow-out has occurred at the side instead of under the protecting mica window. This arcing involves a possible hazard and, besides that, often welds the shell to the cut-out socket, making removal of the fuse difficult.

Thermal time-lag fuse. It doesn't blow if overloaded by starting a motor, but opens if the drain continues too long

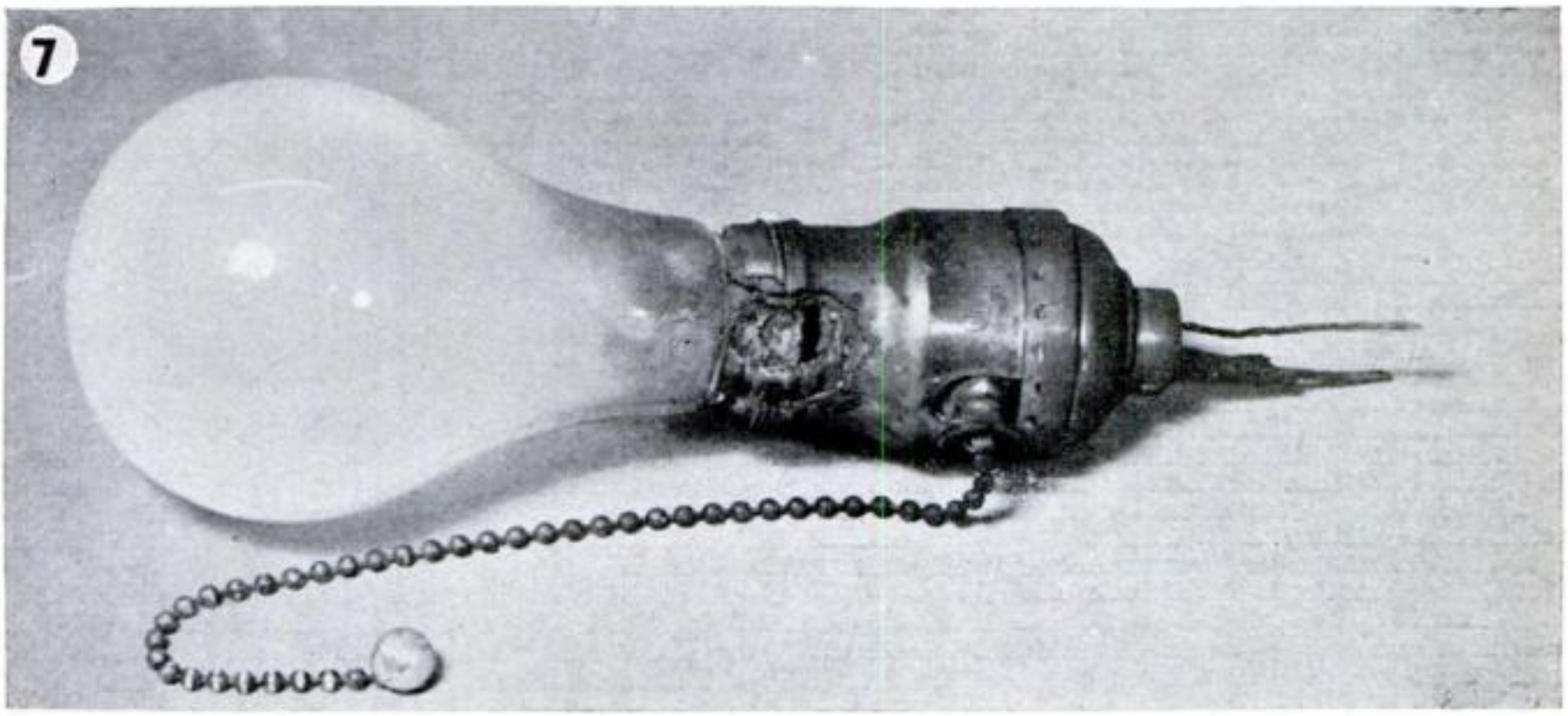
The reason for this trouble is illustrated in Fig. 6, which shows that the threaded brass ring is merely screwed on over the end of the fusible strip, and therefore the contact between the two is often loose. Under load, heating takes place at this point, resulting in the condition shown. Better-quality fuses have the end of the fuse strip soldered or otherwise made secure to the ferrule.

Actually removed from a house lighting fixture was the burned-out pull socket and lamp shown in Fig. 7. This very nearly caused a fire, because hot molten metal dripped from it upon a bed under the fixture. Note how the heat burned most of the insulation off the wires. Would you care to have this happen in your bedroom in the middle of the night?

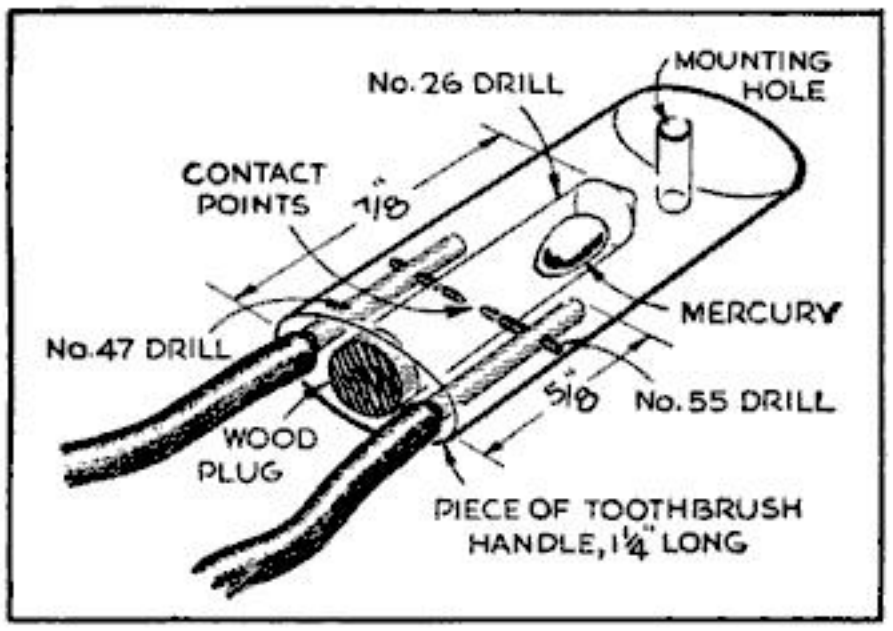
The primary cause of this condition was improper connections at the socket. The live side instead of the grounded side of the line was connected to the screw shell. As there is only a light paper jacket between the shell and the outer casing of such a socket, which casing is normally grounded through the fixture, only a weak spot in the paper was necessary to permit a short circuit. But this might not have done the damage it did if 15-ampere fuses had been in the cut-out. Actually, 30-ampere fuses had been inserted, and considerable fireworks were caused as the brass shell was burned away before the 30-ampere fuses finally blew, following a complete breakdown in the socket.

This mishap occurred at a ceiling fixture. How much greater the danger of possibly serious personal injury when a flexible cord on the housewife's electric iron, the vacuum cleaner, the Christmas tree, or the child's electric-train transformer suddenly flashes and burns because fuses fail to give the protection they should! A short-circuited lamp cord lying in floor lint or under a draped couch cover is an obvious fire hazard that can be minimized only by the use of proper fuses.

It should be remembered that fuses are the safety valves of electrical systems, intended to break the circuit before a dangerously large current can flow. Just as no householder would dream of removing the safety valve on his steam boiler and plugging the hole, so nobody should insert bootleg devices or large-capacity fuses in place of the correct ones that safeguard wiring and keep electricity under control. Such dangerous practices will be made a thing of the past by the new fuses and adapters.



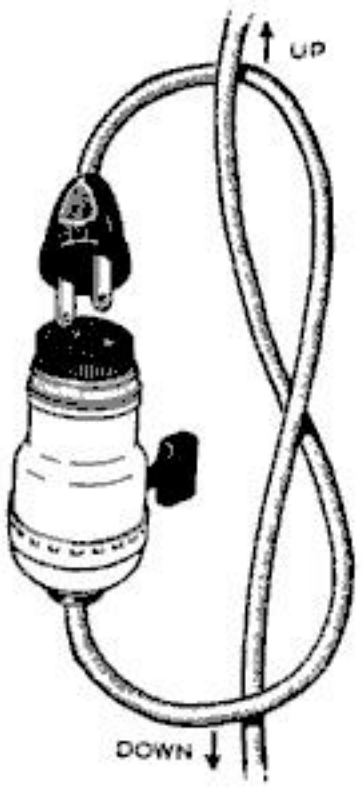
Automatic Mercury Switch Made from Old Toothbrush Handle



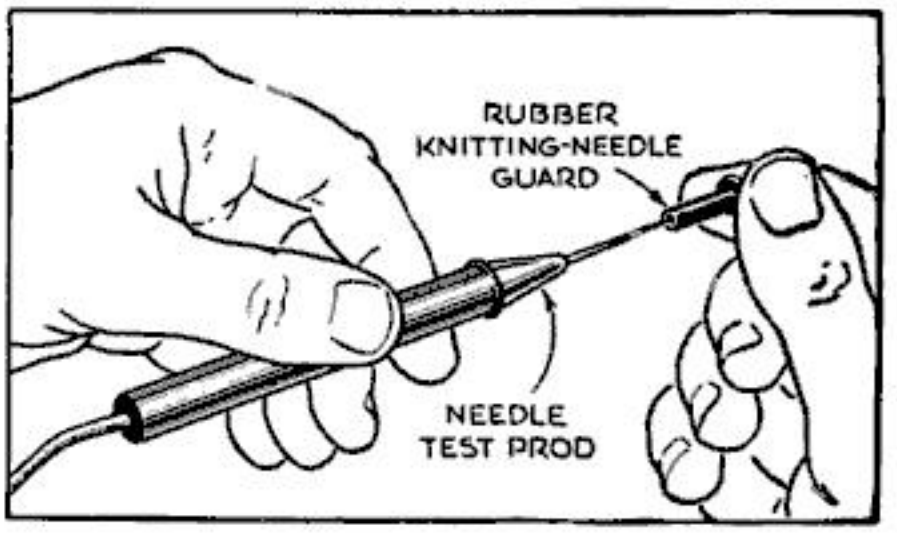
TO ACTUATE an electric mail-box indicator (see P.S.M., Nov. '41, p. 195), an automatic luggage-compartment light, and similar circuits, a mercury switch is ideal. One made as illustrated allows current to flow momentarily when it is tilted—just long enough to operate an annunciator signal or the like. If current is to flow continuously, do not drill the middle hole as deeply as shown, or use a longer plug, so that the mercury cannot run past the contacts when the switch is in the "on" position.

Cut a piece about 1¼" long from an old toothbrush handle, preferably transparent, and drill it as shown. The twisted strands of the lamp-cord leads are pinned in place with pointed brads driven into the transverse holes. Put a drop of mercury in the large hole, and test the switch with a flashlight bulb and battery. Remove or add mercury as necessary until it makes proper contact, yet flows freely away to break the circuit. Cement a bit of wooden dowel into the hole, and mount the switch so that opening or closing the door or lid to which it is fastened will close the circuit as desired.

Shoelace Knot Retains Plug in Hanging Electric Socket



THE plug of a heavy-duty electric extension cord won't work loose from an overhead hanging socket at awkward moments if the line and appliance cord are interlaced with a single or overhand knot—the kind used in preparing to tie a shoelace—before the two are plugged together. The knot will take most of the strain off the plug and socket and put it on the cord.—T. W.

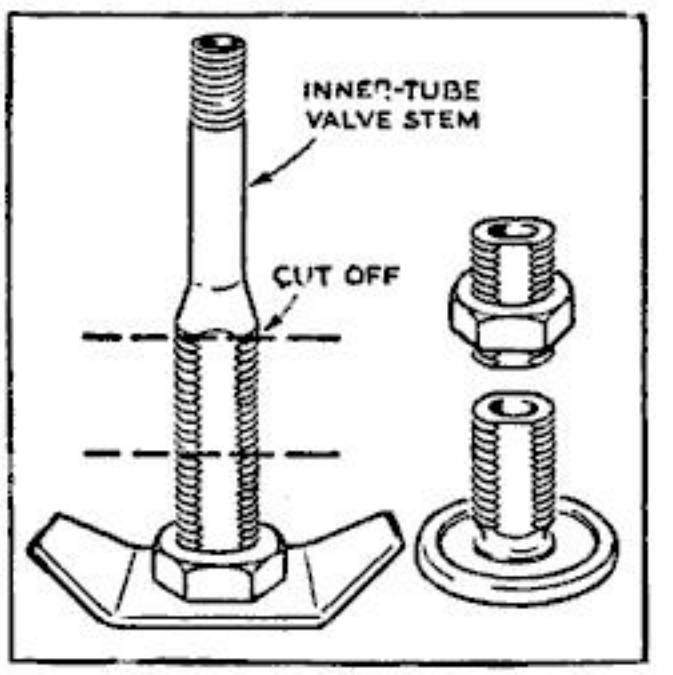


Guards from Knitting Needles Protect Tips of Test Prods

BY USING the rubber guards from knitting needles on the ends of his test prods, one radio service man prevents them from being dulled when placed in his tool box.

Inner-Tube Valve Stem Serves in Place of Electrician's Pipe Nipple

WHEN an electrician's standard ⅛" pipe nipple with its hexagonal nut is not readily obtainable for use in wiring a lamp, an old inner-tube valve stem of the type shown in the drawing at the right can be made to serve as a substitute. The flattened sides of the valve stem are gripped in a vise, the stem is cut to the desired length, and the hole is enlarged to ¼" by drilling. Fittings for two lamps, in fact, may be made from one stem by cutting it in half and using the hexagonal nut to tighten up one part and the enlarged valve-stem base to tighten the other.—J. S. TURNBULL.



You can make ethyl alcohol from potatoes. As the first step, mash bits of raw potato in water and boil. Then, to change the starch into sugar, heat the solution five or ten minutes with dilute sulphuric acid as at left. Subsequent steps are illustrated on the following page

MAGIC OF CHEMURGY

DUPLICATED IN THE HOME LABORATORY

PAINTS, glues, and plastics from skimmed milk; lacquers and synthetic resins from soybeans; alcohol from potatoes, corn, and grain; film, rayon, explosives, and leather substitutes from wood pulp and waste cotton! These are just a few of the magical transformations of the chemurgist, who turns food-product waste and surplus into industrial plenty.

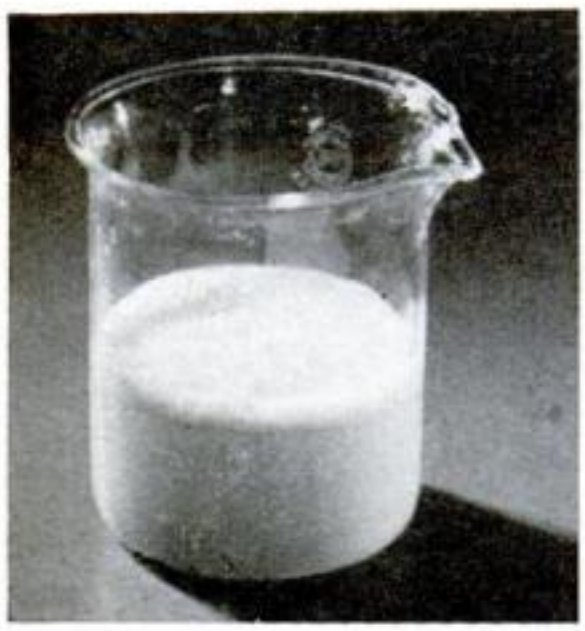
Until only a few years ago, the basic materials of industry were chiefly mineral products. Today, facing a scarcity of these resources, chemists are creating substitutes from products of farm and forest.

In your own home "lab" you can demonstrate how filaments of viscous cellulose solution are spewed from mechanical silkworms to produce rayon. You can make alcohol, and transform the casein of milk into glue and paint.

In commercial processes for making rayon, cellulose, the fibrous cell material of plants, is the principal raw material. In the viscose process, it takes the form of wood pulp from spruce trees; in the cuprammonium process, which produces a slightly "silkier" type of rayon, bleached wood pulp and bleached cotton linters (the short fibers of cotton that are not worth spinning) are used. The cuprammonium process will be described here.

First we make a few grams of copper hydroxide. Dissolve a meager teaspoonful of copper sulphate crystals in half a test tube of water. Then slowly stir in a little 28% ammonium hydroxide (strong ammonia water). This changes the copper sulphate into copper hydroxide, precipitating the latter to the bottom of the tube. Allow this precipitate to settle, and add more

Fermentation of the sugar solution by yeast germs turns part of it into alcohol. The froth formed during fermentation is caused by liberation of carbon dioxide gas. In the industrial manufacture of alcohol, this gas is a valuable by-product



That the fermented solution contains alcohol may be proved by dropping a little of it into a test tube containing potassium bichromate and sulphuric acid. When heated, the test solution (normally yellow or orange) takes on a greenish tint, showing that alcohol is present

ammonia until precipitation stops. Now filter the precipitate and wash in several changes of water.

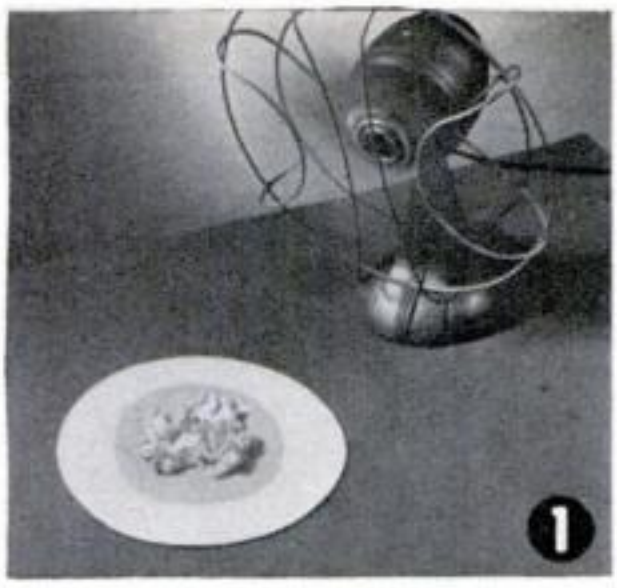
We next dissolve the solid copper hydroxide by adding more strong ammonia. About 50 cc. of 28% ammonia should be added to 3½ grams of copper hydroxide. This solution is our solvent for the cellulose, which may be pieces of filter paper. Dissolve about two sheets of 9-cm. paper, or enough to make the solution run like sirup. If it becomes too thick, thin it with ammonia.

To make our rayon from this sirup, we must force it through a small hole into a solution which will cause it to harden in the form of a thread. We can produce a hole small enough for our demonstration by drawing out the end of a glass tube in a Bunsen flame. We use this tube as the nozzle of a syringe, put together as shown.

Pour some of the solution into the syringe, and force it out through the nozzle into a

Copper hydroxide for the rayon experiment is prepared by adding strong ammonia to a solution of copper sulphate. The pale-blue precipitate is copper hydroxide, a basic material in the cuprammonium process of rayon manufacture

How rayon is made by the cuprammonium process: Cellulose (in this case bits of filter paper) is dissolved in a solution of copper hydroxide in strong ammonia. The resulting solution is forced out through a capillary nozzle of the homemade syringe at the right, into sulphuric acid which hardens the thread



CASEIN GLUE AND COLD-WATER PAINT are easily prepared in the home laboratory. Dilute some milk with water and stir into it some dilute hydrochloric acid. The casein precipitated is washed with water and alcohol and dried in the blast of a fan (1). Mixed with water and sodium hydroxide (2), it makes good waterproof glue; mixed with lime, whiting, and borax, it makes good cold-water paint (3)

dilute solution of sulphuric acid in water. As it contacts the dilute acid, the cellulose hardens, and writhes about. As it emerges, it has still the deep-blue color of the original solution; but gradually the blue vanishes as the ammonia is removed from the thread. In commercial rayon manufacture, the process is completed by stretching the thread, removing it from the acid, and drying it in warm air.

To duplicate the feat by means of which chemurgists take skimmed milk and turn it into cold-water paint and strong glue for every woodworking job, we start with only half a glass of milk from which the cream has been removed. Add to this an equal portion of water, and then stir into it slowly a little hydrochloric acid, diluted one part acid to four of water. The acid "turns" the milk, forming a precipitate which settles to the bottom. Slowly add more acid until no more precipitate forms.

The white precipitate is the complex milk protein, casein. We recover this by filtering the solution through cheesecloth. After the liquor has run through, follow it with quantities of cold water, to wash away impurities. Further purification may be obtained by rinsing with alcohol. The casein should then be dried with a hair drier or electric fan.

Glue may be prepared from the casein by first mixing ten parts of this protein with 20 parts of water until all the water has been absorbed. Then prepare separately a solution of 1 part of caustic soda (sodium hydroxide) in 5 parts of water. Add this slowly to the damp casein, stirring constantly. If the glue thus formed is too thick it may be thinned by adding water; if too thin, it may be thickened with casein.

You may make your casein paint by mixing equal parts of casein, lime, and whiting, and a few grains of borax. Grind the materials together in a mortar, and then add water while you grind, until you obtain a suitable consistency for paint.

Alcohol may be made from grains, corn, or even potatoes. Mash up some bits of raw potato or corn kernels with a little water, and boil in a test tube for several minutes. After the solution has cooled, a drop of iodine solution mixed with it will turn the solution black, indicating the presence of starch, which is changed into sugar by heating for five or ten minutes with dilute sulphuric acid. After the solution has again cooled, drop a small piece of yeast cake in it, and stand it aside in a warm place for several days. The yeast germs change part of the sugar molecules into alcohol and liberate carbon dioxide.

High-Fidelity Amplifier

FOR YOUR P A SYSTEM, PHONOGRAPH, OR F M RECEIVER

EXTREMELY versatile, this 10-watt audio amplifier may be used with either a crystal or magnetic pick-up for playing recorded music, with a crystal microphone for public-address work, as an amplifier for a high-fidelity tuned radio frequency or superhet tuner, or as an amplifier for use with an FM receiver, such as the one described in a recent issue (P.S.M., Dec. '41, p. 202).

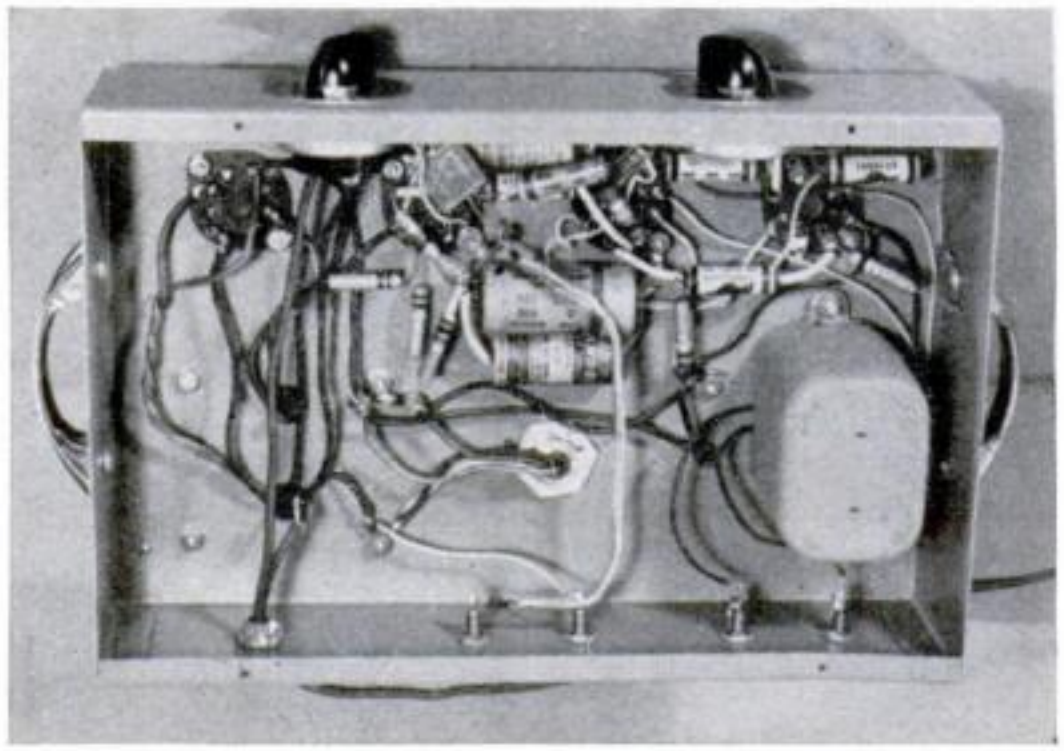
The amplifier employs a unique output, two different types of tubes being used in a push-pull circuit. A 6AD7G is used on one side of the circuit while a 6F6G is used on the other. The pentode section of the 6AD7G, however, has the same characteristics as the 6F6G, and the triode portion of the 6AD7G is used as a phase-inverter tube. No push-pull audio transformers are used. Instead the first audio stage (6SJ7) is resistance-coupled to the push-pull output stage.

The input is fed through a .005-mfd. mica condenser and 500,000-ohm volume control to the grid of the 6SJ7. This tube is one of the newest types, using the single-end construction where the grid cap has been eliminated from the top of the tube—the grid being connected to one of the prongs on the base of the tube. This, of course, helps to enhance the general appearance of the amplifier, since no wires are visible above the chassis.

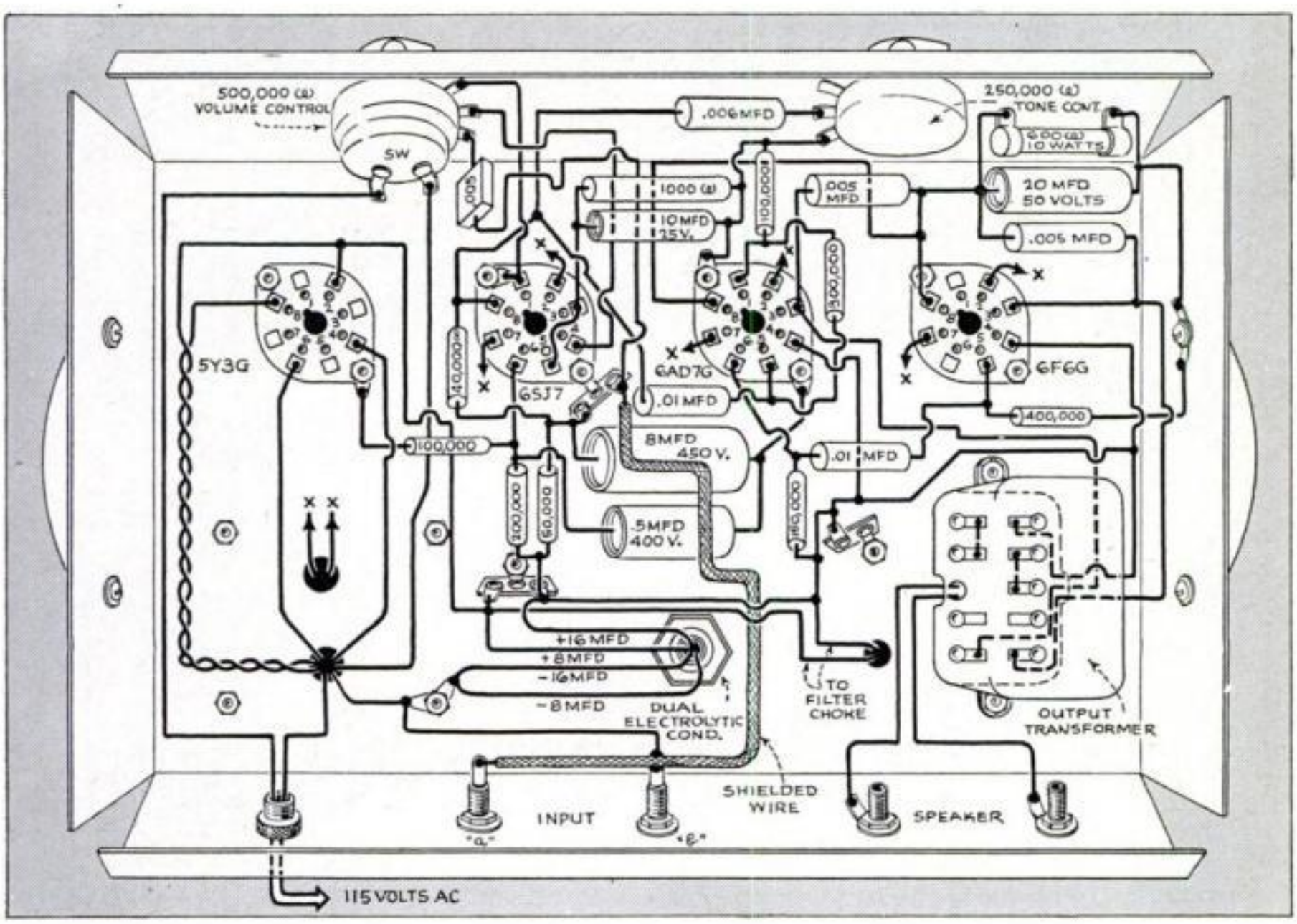
In the plate circuit of the 6SJ7 there is a tone control consisting of a .006-mfd., paper tubular condenser in series with a 250,000-ohm variable resistor—one side of the variable resistor being grounded to the chassis. This tone control really acts as a treble control. In other words it cuts out only the high notes without affecting the low notes. No control for the low notes was considered necessary, as these are reproduced by the amplifier to their full value.

The new amplifier (right, above) in use with the FM receiver built from plans in the December 1941 issue of Popular Science

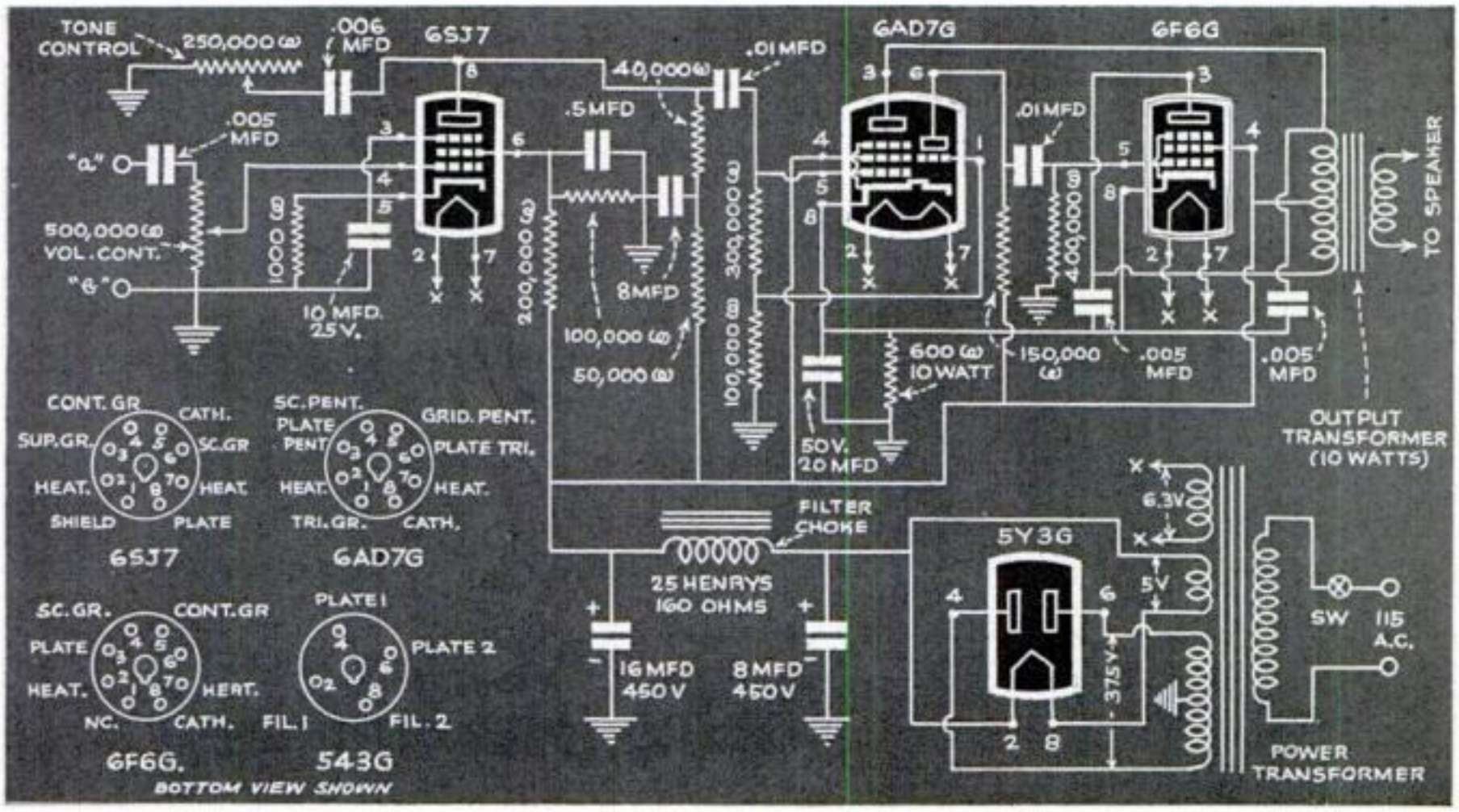
Close-up top view of amplifier with cover removed. This and the bottom view of chassis below will help you locate parts

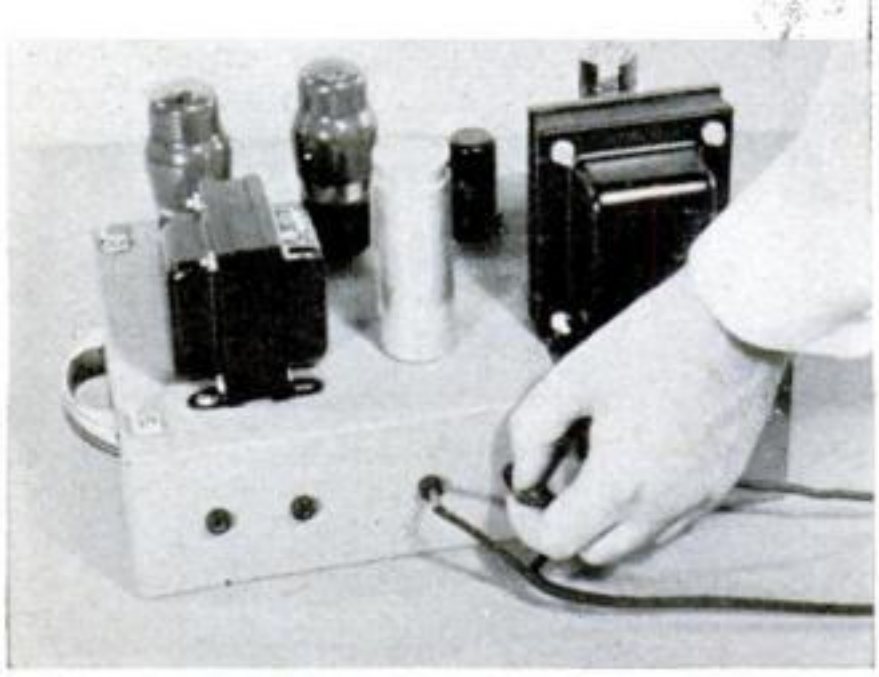


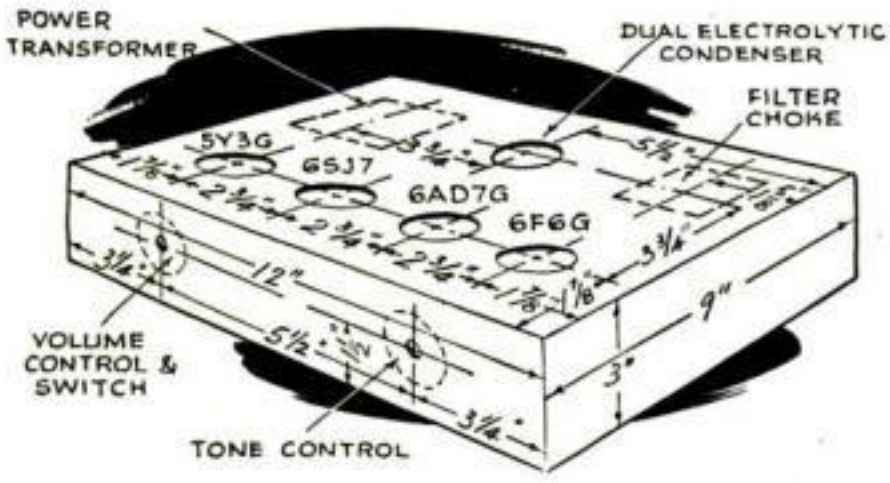
The plate and screen-grid circuits of the 6SJ7 are elaborately decoupled to avoid feedback. This helps to reduce hum and instability in the amplifier. An adequate filtering system is also used in the rectifier circuit—the 350-volt output from the 5Y3G full-wave rectifier being filtered by the 8-mfd. and 16-mfd., 450-volt electrolytic condensers and the heavy-duty, 25-henry filter choke. This choke is rated to pass 140 milliamperes. The power transformer, operating on 110 to 115-volt A.C. only, has three secondary windings: a 6.3-volt winding rated at 3½ amperes for the tube heaters, a 5-volt



The plan diagram above (compare with underchassis view at bottom of opposite page) shows not only where each part is placed but the general path of the connecting wires. Below is shown the schematic wiring diagram. Bottom view of the tubes (below, left) identifies terminals (prongs) of tube elements

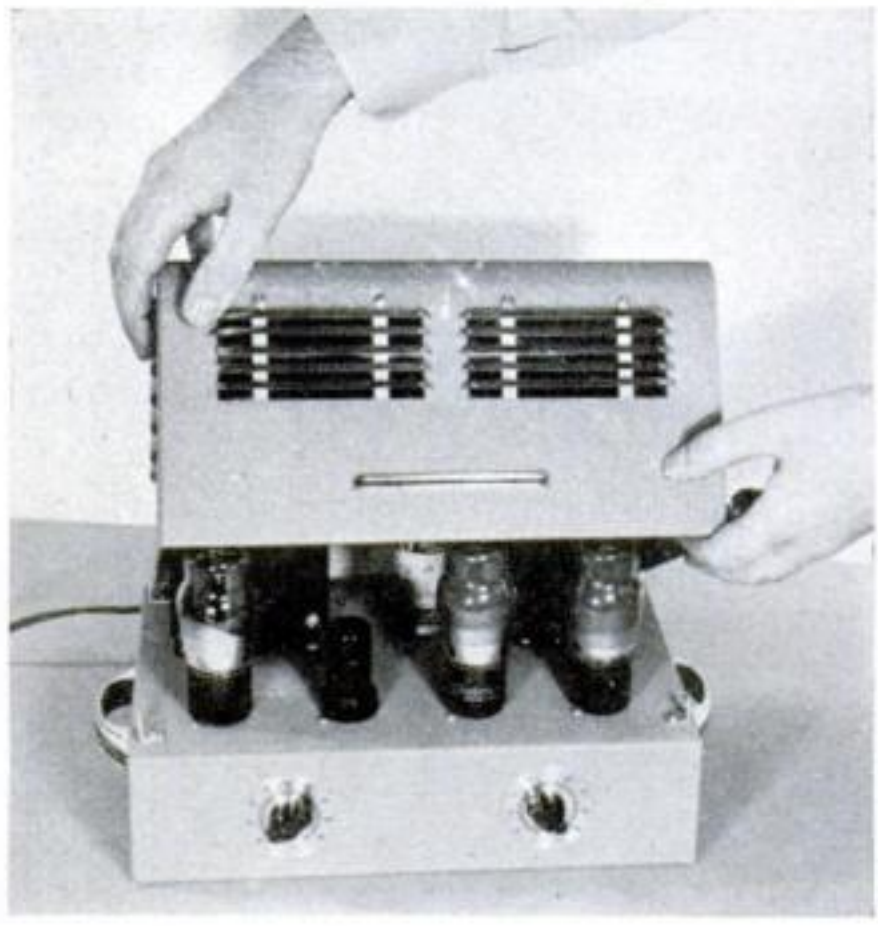






Dimensions of the chassis and additional data on positioning of parts are given in the drawing above

Back of amplifier with the cover removed is shown at the left. Note the jacks for the microphone, phono, or radio connections in the center. At far left are two banana-plug jacks for speaker connections. In the front view below, the cover is being removed. Note the attractive ventilators, handles, and moldings. Chassis finish, marine gray ripple enamel



winding rated at 3 amperes for the rectifier's filament, and a high-voltage winding rated at 375 volts, 90 milliamperes. The power transformer is fully shielded to protect the windings and to reduce hum pick-up to a minimum.

In connecting the high-fidelity audio amplifier with the FM receiver described in a recent issue of POPULAR SCIENCE, the power tube (6F6) in the receiver will have to be removed from its socket and a short piece of shielded hook-up wire connected to the control-grid pin (No. 5) on that socket. The other end of the wire is connected to terminal "a" on the amplifier, while the braided shielding on the wire is connected to terminal "b." The shielding on the wire will also have to be grounded to some point on the chassis of the FM receiver.

The speaker should be at least an eight-inch model—preferably 10 or even 12 inches. It should be a permanent-magnet type with a voice coil of 6-8 ohms. It should be mounted on a good-size baffle (40" square) or a properly designed cabinet. There are several special console-type speaker cabinets available which are especially useful with high-fidelity speakers. In selecting one of these for use with the amplifier, the set builder may be governed by his individual taste and requirements.—ARTHUR C. MILLER.

LIST OF PARTS

Shielded power transformer, 115 volt, A. C.
Universal output transformer.
Filter choke, 25-Henry, 160 ohm.
Amplifier cabinet, 8" by 9" by 12".
Control knobs, red (two).
Dial plates, chrome, (two).
Volume control and switch, 500,000 ohm.
Tone control, 250,000 ohm.
Octal wafer sockets (four).
Tubes: 6SJ7, 6AD7G, 6F6G, and 5Y3G.
Electrolytic condensers:
- Dual, 8—16 mfd., 450 volt.
- Tubular, 8 mfd., 450 volt.
- Tubular, 10 mfd., 25 volt.
- Tubular, 25 mfd., 50 volt.

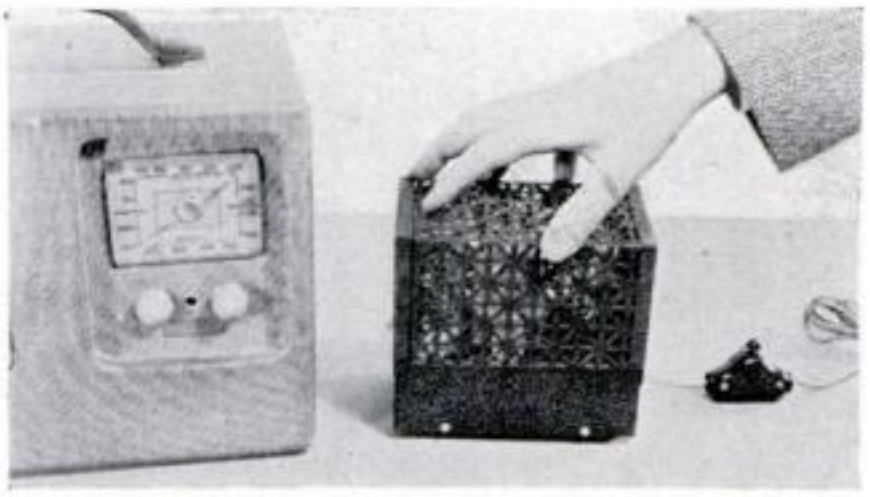
Mica condenser, .005 mfd., 600 volt.
Paper tubular condensers:
- .01 mfd., 400 volt (two).
- .005 mfd., 400 volt (two).
- .006 mfd., 400 volt.
- .5 mfd., 400 volt.

Carbon resistors:
- 400,000 ohm, 1 watt.
- 300,000 ohm, 1 watt.
- 200,000 ohm, 1 watt.
- 150,000 ohm, 1 watt.
- 100,000 ohm, 1 watt (two).
- 50,000 ohm, 1 watt.
- 40,000 ohm, 1 watt.
- 1,000 ohm, 2 watt.

Wire-wound resistor, 600 ohm, 10 watt.
Insulated phone jacks, red (two).
Insulated banana jacks, red (two).
Line cord and rubber plug.

Radio Ideas

A NEW LOUDSPEAKER BAFFLE, used for paging and announcing in large industrial plants, projects sound in all directions by means of five evenly spaced apertures in a horizontal plane. The unique feature of this baffle is its construction of nonmetallic, nonvibratory material especially made for the purpose by RCA. It distributes sound pressure evenly throughout a radius of 50 feet. It is designed for operation with 5, 10, 12, or 15-watt loudspeaker mechanisms.

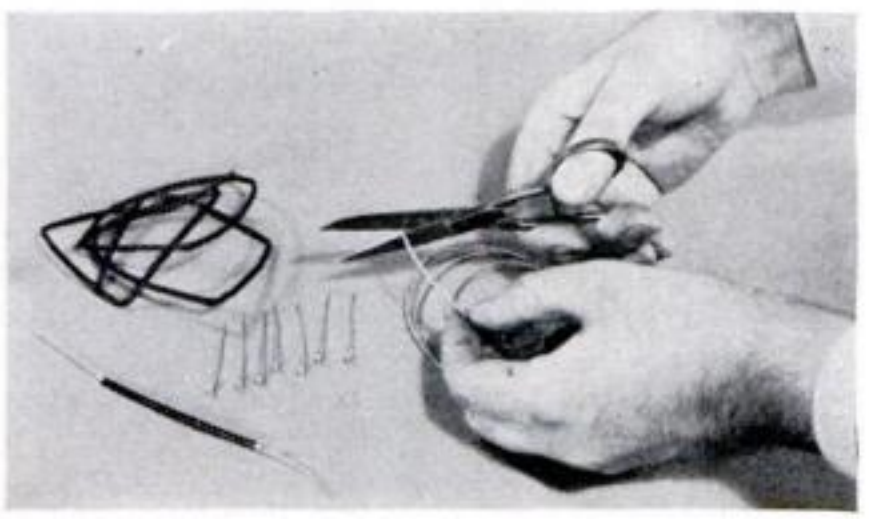


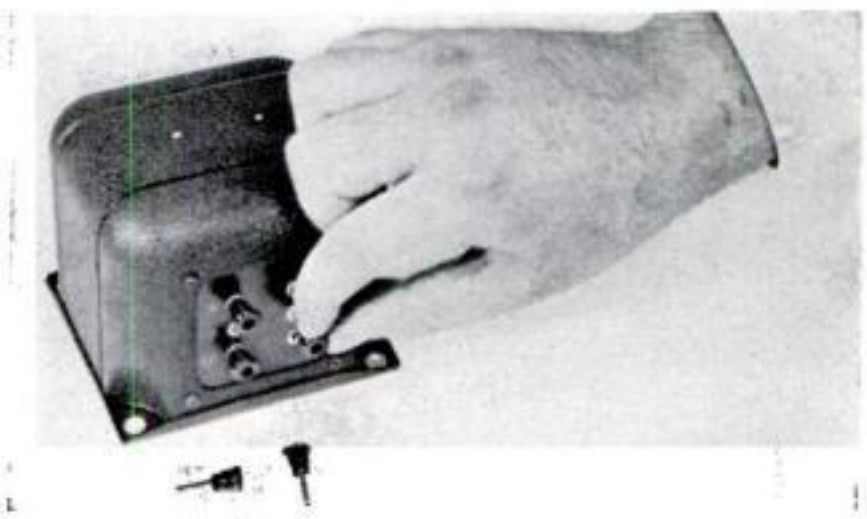
THE COMPACT CONVERTER pictured above enables the owners of 1½-volt portables to operate their receivers from the 6-volt storage battery in the car. When connected to the car battery, the converter supplies 1½-volt "A" current for either four, five, or six tubes, and 90-volt "B" current. It fits all types of battery plugs.

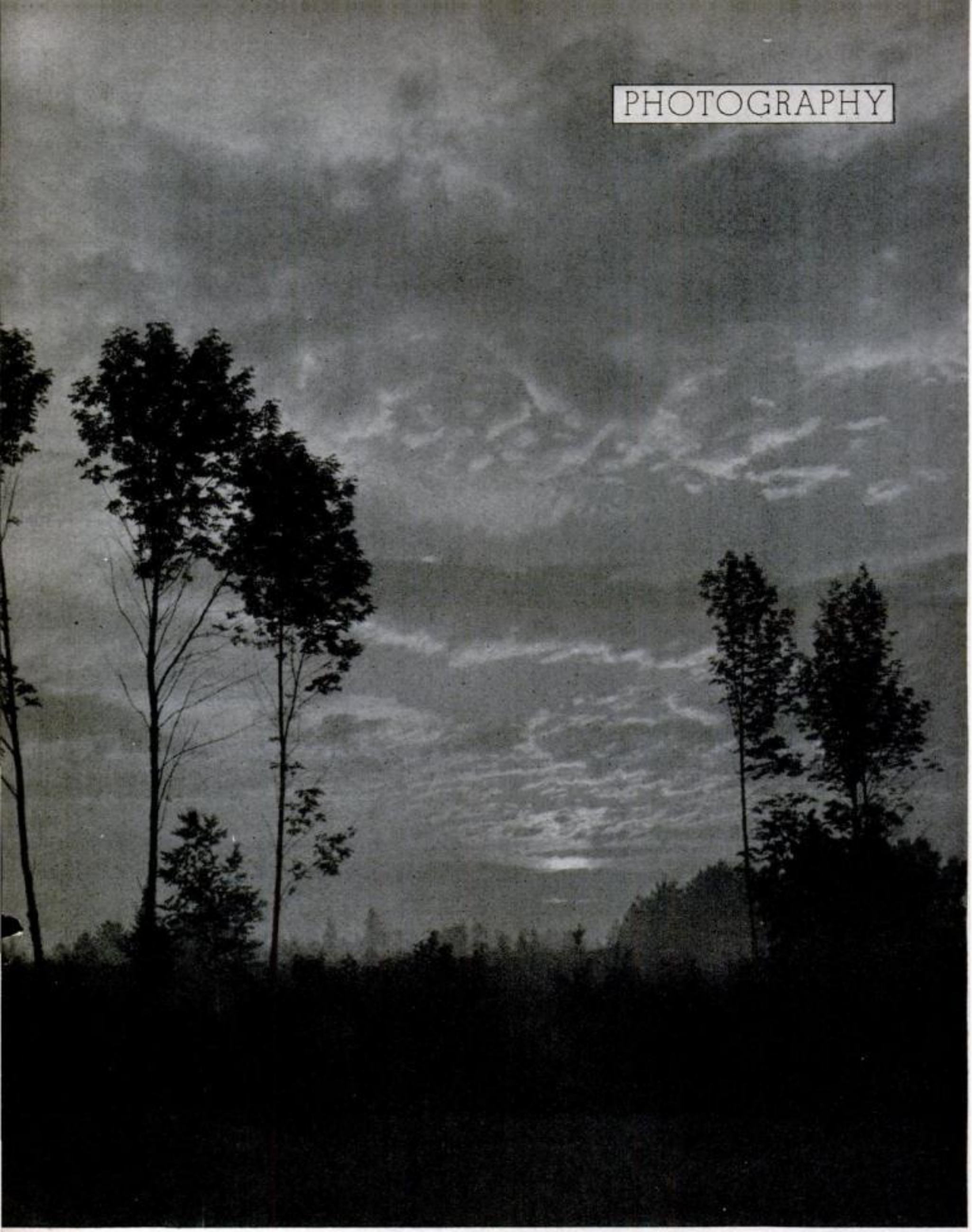
ROTARY RECORDER BRUSH. The brush shown above keeps the path in front of the record cutter free from shavings that would jam the stylus. Available in two sizes, one for a 10-inch turntable and another for 12 and 16-inch turntables, it has a flange at one end with a hole to fit the center spindle of the revolving unit.

A RESISTANCE KIT, containing all the necessary materials to construct flexible resistors with a wide range of values, is now available to amateurs. The kit, which sells for $.75, contains 24 spiral wire leads, 1 yard of spiral wound resistance wire, and a yard of insulated braid.

A TERMINAL PLUG-IN BOARD, on the casing of a new modulating transmitting transformer, makes it possible to vary the primary to match any class "C" secondary load of from 3,000 to 15,000 ohms, simply by placing the plugs in different sockets. Primary loads are adjustable from 2,000 to 20,000 ohms.







PRINTING AT ITS PEAK. This is a type of subject matter that is not only hard to keep within the range of a film, but also very difficult to put on paper. Even the slightest overexposure or underexposure will cause that subtle atmospheric charm to be lost. To obtain this result, Konrad Cramer, who tells in the following article how to do good projection printing, used a Defender Arrow panchromatic negative, underexposed and overdeveloped in Panthermic 777 to gamma 1.2. The print was given normal exposure on Velour Black No. 2 and fully developed in amidol

BETTER PRINTS

...and How to Make Them

By KONRAD CRAMER

Director, Woodstock School of Photography

THE three major steps in the evolution of a photograph are the visualization of the photograph to be, the making of the negative (see P. S. M., Mar. '41, p. 210), and, last but by no means least, the making of the print. The print is the crowning achievement of the amateur photographer's effort. Without a good print the best photograph remains unborn, the best negative is but a hope to be fulfilled.

To squeeze the last drop of goodness from a negative is the supreme pleasure. Many people imagine they have a grand idea for a short story, but nobody will know it unless they put it down in black and white; and many think they have a good negative, and again no one will know unless they make a perfect print. To help you make "the perfect print" is the aim of this article.

There are many good enlargers which, properly used, will turn out perfect prints. Here are some things to look for:

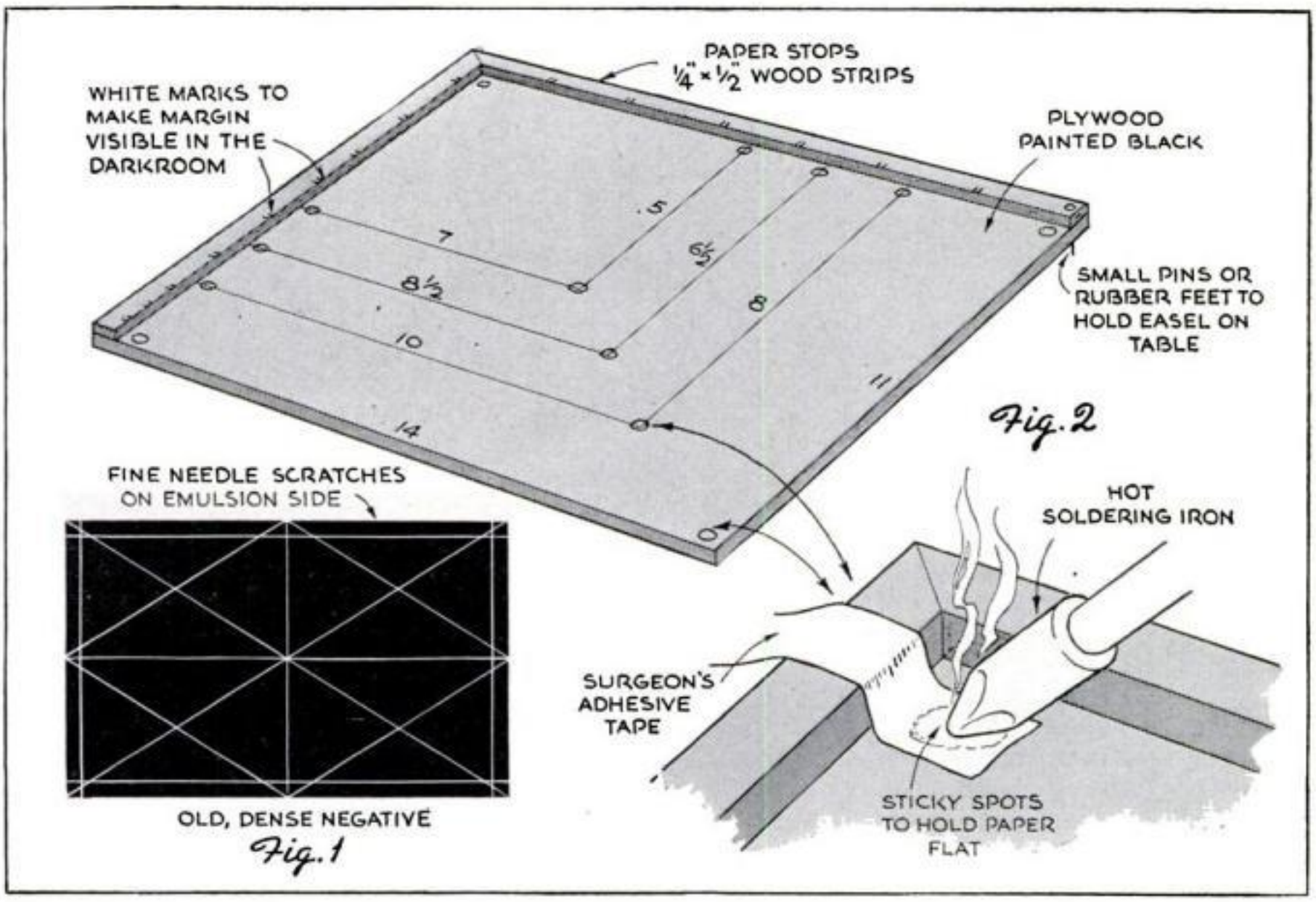
The base (table) must be absolutely level, firm, and at a convenient working height. The baseboard must also be level in relation to its support and the negative carrier. Any departure will cause distortion, and the point of absolute focus may vary, but intentional tilting may be used to achieve certain changes (slanting lines straightened, round faces elongated). A test negative should be inserted to check for correct alignment. It can be made by scratching a number of diagonal lines on an old, dense negative with a needle (Fig. 1).

Adjustments should operate smoothly, without backlash or free play; and once set, it should be possible to lock them.

The negative carriers should be accurately made and glassless. Good glassless carriers can be made even for the larger negative, including 4" by 5". Glass sandwiches, as the book type of carrier is called, have two main disadvantages: they are hard to keep clean, and the image passing through may lose some of its sharp definition.

The light source should be *intense* enough

Fig. 1, the diagonals on a test negative for the enlarger are needle scratches. Fig. 2, an easel, to be painted black, lined in white, and gummed in spots by pressing a hot soldering iron on adhesive tape



to make long exposures (60 seconds and more) unnecessary, and the light should be evenly distributed over the entire negative. This even spread is achieved by various means: diffusion (opal glass or ground glass between light source and negative), collecting lenses (condenser systems), and dispersion lenses. Enlargers using condensers seem to produce a more brittle and sharper image.

The temperature of the light house should be as low as possible. Enlargers that fry, bake, or broil the negative are undesirable and dangerous. A light source made of grids of mercury and argon-filled glass tubes is ideal from this standpoint. While this light is cold, it has the drawback of giving relatively poor visibility of the image.

An easel (Fig. 2) that will hold the paper flat and immovable on the baseboard is excellent, and can be put together easily.

A foot switch in the enlarger circuit is almost a necessity, for there are moments during printing when one literally has both hands full.

TO EXCLUDE or admit the light to the print at will, several dodgers (Fig. 3) are necessary and can easily be made: *(a)* a small ball of cotton on wire; *(b)* an oval piece of black cardboard on a twisted wire handle or narrow strip of glass, with an edging of fluffed cotton (the cotton prevents sharp edges and makes blending easier); *(c)* similar to *b*, a useful shape for sky and cloud printing; *(d)* and *(e)* cardboard frames, larger than the printing paper used, black on the side facing the paper, white on that facing the negative, and edged with cotton.

But the best dodging tools of all are the photographer's two hands. To the uninitiated, the strange antics of an expert's hands are amazing. But each movement has its meaning. Let your eyes follow the little pool of light as it hovers over a high-light area. Observe how two fingers stretched out (Fig. 4 at left) will shade two trees and the entire foreground in a sunrise landscape while the sky is given additional exposure, or how the cupped hands (Fig. 4 at right) admit extra light to a face. Throughout all the dodging time, the hands and the dodging tools must be kept constantly in motion to prevent the forming of hard edges.

To make an excellent diffuser (Fig. 5), get from the five-and-ten-cent store a pair of embroidery hoops and a clear sheet of cellulose wrapping material. Crumple the sheet until it is filled with very small wrinkles, carefully smooth it out again, and stretch it between the hoops, which have been painted a dull black to guard against reflections. The screen cuts down exposure time only slightly, and if used about one third of the exposure time, the illusion of sharpness is retained. For a flattering portrait its use is often invaluable.

The last and perhaps most important gadget is a piece of red gelatin (a little larger than the lens) such as is used in front of stage lights. This may be fastened to the enlarger so it can be swung under the lens, or it may simply be held in the hand.

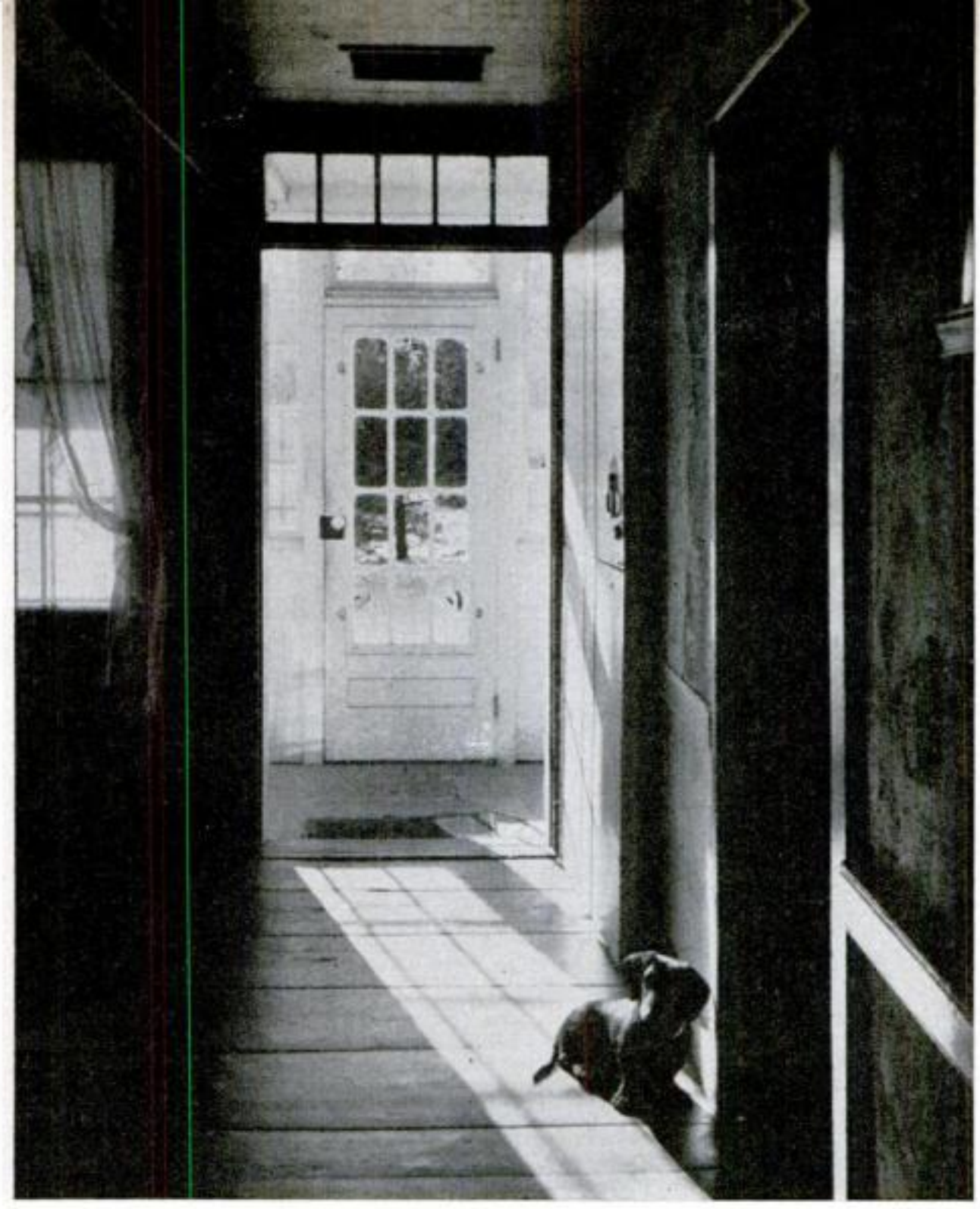
Now let us make a print: Put into the *clean* enlarger an average negative (not too thin, not too dense), emulsion side towards the paper. Turn on the light of the enlarger, and determine the size you want the projected image to be. Then, with the lens wide open, focus the image sharply. Take great pains in getting maximum definition. Focusing magnifiers are helpful in this.

You must also determine how much light to project on the paper you are using to obtain a correctly exposed print. Assuming you are using a normal bromide paper, the most reliable method of determining print exposure time is as follows:

With your normal darkroom lights on (Wratten safelight series O. A.), open the lens of your enlarger all the way, then interpose the red gelatin filter between the lens and the paper so that the picture is transformed into a deep red image. While keeping your eye on the projected image, slowly close the lens diaphragm until the picture reaches the *threshold of visibility*. This means you should be just able to make out the entire picture in a faint red glow. Now remove the red filter, and you will see the image appear considerably clearer.

THIS threshold of visibility of the red image can be used as a constant factor. For a thin film, you will have to close the lens a bit further, but when you again reach the threshold of visibility *the amount of light reaching the paper will be the same as in the case of the average density film,* and therefore the exposure time should be the same. A very dense negative may use so much light that the threshold of visibility will occur with the lens wide open, but whatever the *f*-number of the lens, the amount of light reaching the paper will again be the same. If, because of a very strong light, you can still see the red image when the diaphragm is closed as far as possible, you might have to place a second sheet of red gelatin over the first.

After a few experiments you will arrive at a time constant for a given paper, let us say, 11 seconds for Velour Black, normal; then it is easy to make time corrections for the other grades and types. If economy is important, these preliminary exposure experiments can be made on test strips of



Almost the right exposure from a negative difficult to print. The picture at left and the one below from the same negative illustrate two methods of achieving an artistic result. In either case, the reluctant dachshund, Mr. Cramer's dog Hypo, seems unaffected by the problem in photographic prints his master solved

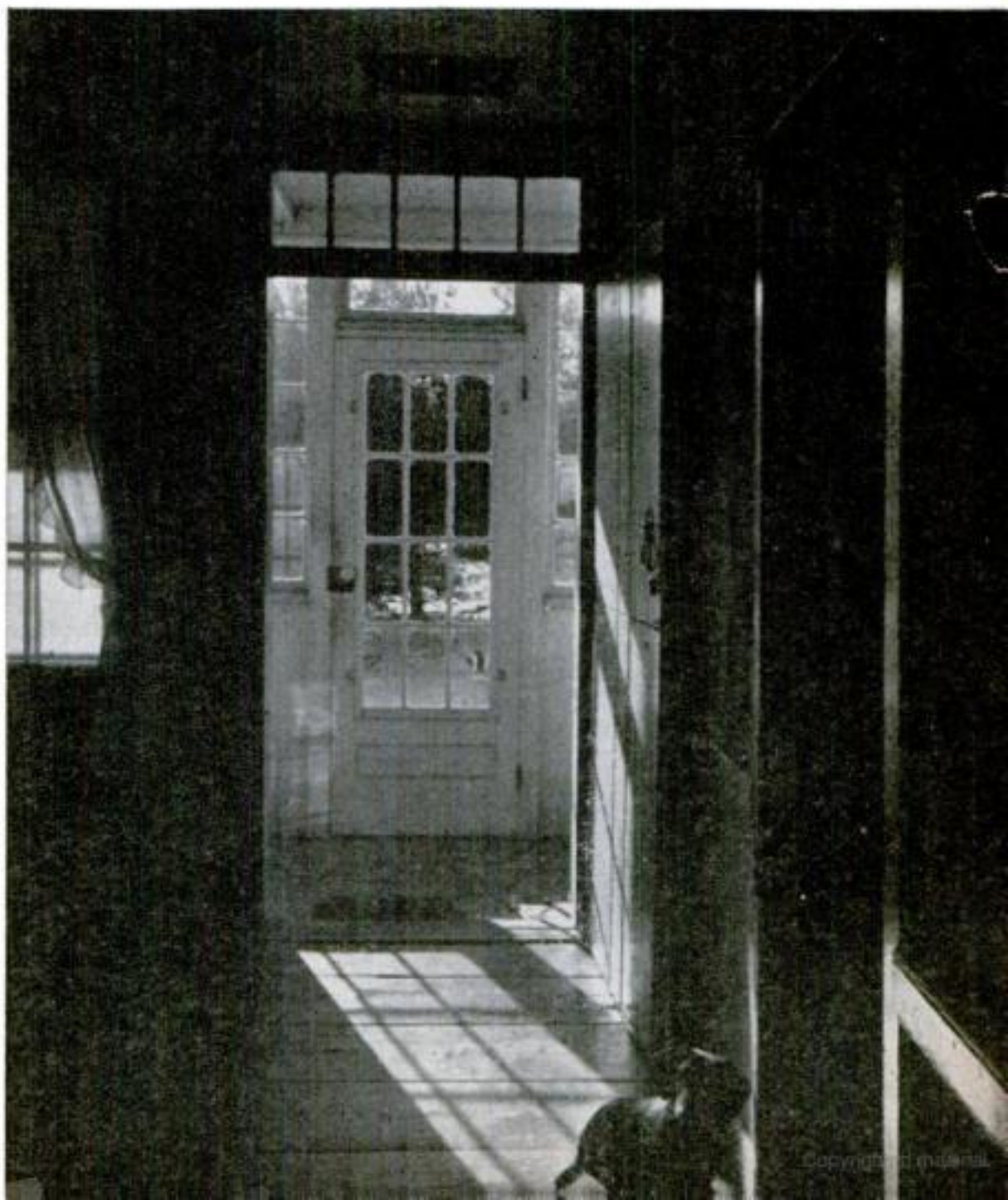
Below is a full exposure on Velour Black paper which was given comparatively short development in an amidol solution to which an extra amount of potassium bromide had been added. Most artists would prefer this print because of the illusion of light and the snow effect outside the door

printing paper. A record of the variation in the time factor between normal, hard, and soft papers should be carefully recorded (see relative exposure times for papers in any handbook). We use this simple and speedy method in the Woodstock School of Photography, and it results in a minimum of wasted paper through incorrect exposure.

I know of no other method that will give the *correct* exposure time more speedily, but unfortunately it does not tell us anything about the *right* exposure, which will transform a *print* into a *picture.*

After the paper has been exposed for the required time, it is placed in the developer tray filled with the developer recommended by the paper manufacturer at the recommended temperature. Slide the paper into the solution in the manner of a very shallow dive.

The main object is to have the paper completely and quickly immersed to prevent uneven development. Rock the developer tray



continuously from right to left and from back to front. An easy method of doing this is illustrated in Fig. 6.

After the print has been in the developer for the *minimum time* specified by the manufacturer of the paper, the print may be removed. To remove a print before this minimum developing time has elapsed is the *major error* committed by the inexperienced.

If your print seems too dark, the only remedy is to expose a new piece of paper for a shorter time. The desire to rescue a print by snatching it from the developer tray may save something of an image, but it is not a photographic print. Underexposure is worse, as it fails to convey an idea of the quality of the negative. Many photographers turn out bad prints simply because they are afraid of overexposure.

The following is the quickest way to become a good printer: Place a normal negative in the enlarger and expose on a normal white glossy paper, giving a *generous* exposure. Slide the print into a tray of amidol paper developer, which you will have to mix fresh as follows, because it won't keep:

Water	32 oz. or 1 liter
Sodium sulphite	1 oz. or 30 grams
Amidol	¼ oz. or 7½ grams
Potassium bromide (10% solution)	1-2 oz. or 30-60 cc.

This developer causes the image to appear as a whole from the beginning; and by carefully observing the progressive stages of development, the beginner will see at a particular moment *just the picture he wants,* but as we have intentionally given too long an exposure, the print will keep getting darker. Try to remember now just how dark the picture was that you liked best, and adjust your subsequent exposures so that your print will reach this same degree at the completion of the *entire (maximum) developing time.* You will achieve quality much sooner if you have the courage to *overexpose* in the beginning.

That much-used and poorly understood term "print quality" can only be achieved by strict adherence to these rules:

Rule 1. Don't enlarge your negatives too much in the beginning. Even the best amateurs find it difficult to get print quality into an 11" by 14" from a 35-mm. negative. You will learn to make good prints quicker if you make them smaller. A 5" by 7" that has quality is far better than an 11" by 14" that looks like a coarse-screen newspaper cut. Don't fret about grain size. Long before the grain is visible to the eye, print quality has ceased to exist. Get hold of a really good contact print from an 8" by 10" made by a professional, hang it up in your darkroom, and check your own results against this standard.

Rule 2. Don't confuse the *correct* print with the *right* print. The right print is the one that best expresses your picture idea.

Rule 3. Don't, in the beginning, experi-

Fig. 3, a group of dodgers necessary in excluding or admitting light to parts of a print. Fig. 4, use of hands in dodging. Fig. 5, a diffuser made from embroidery hoops and transparent paper. Fig. 6, a rocking developer tray. The rubber-headed nail in the larger tray permits rocking in any direction

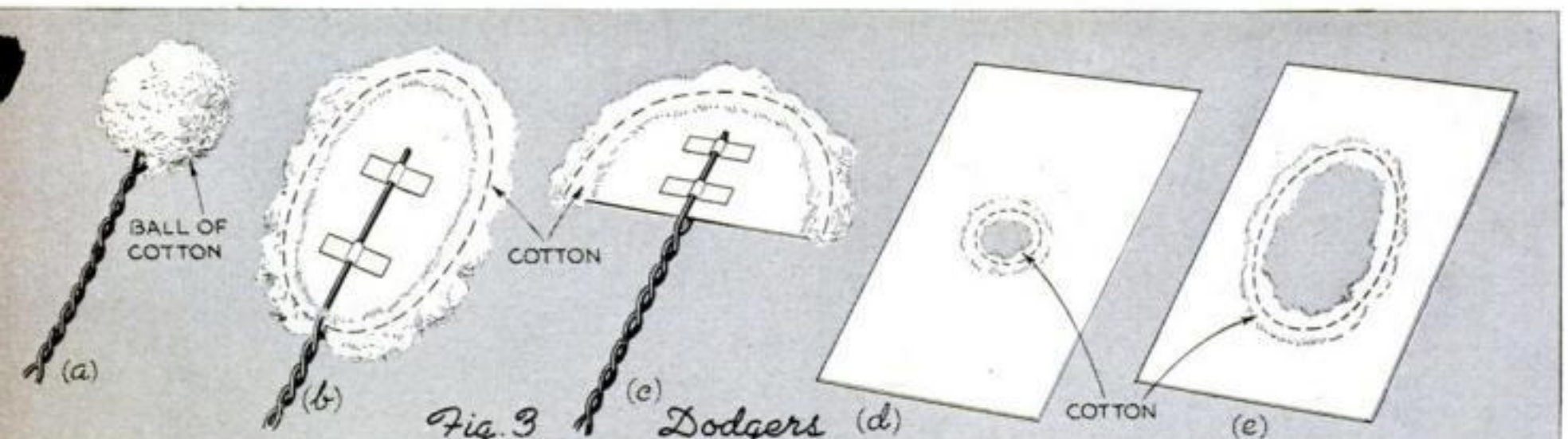
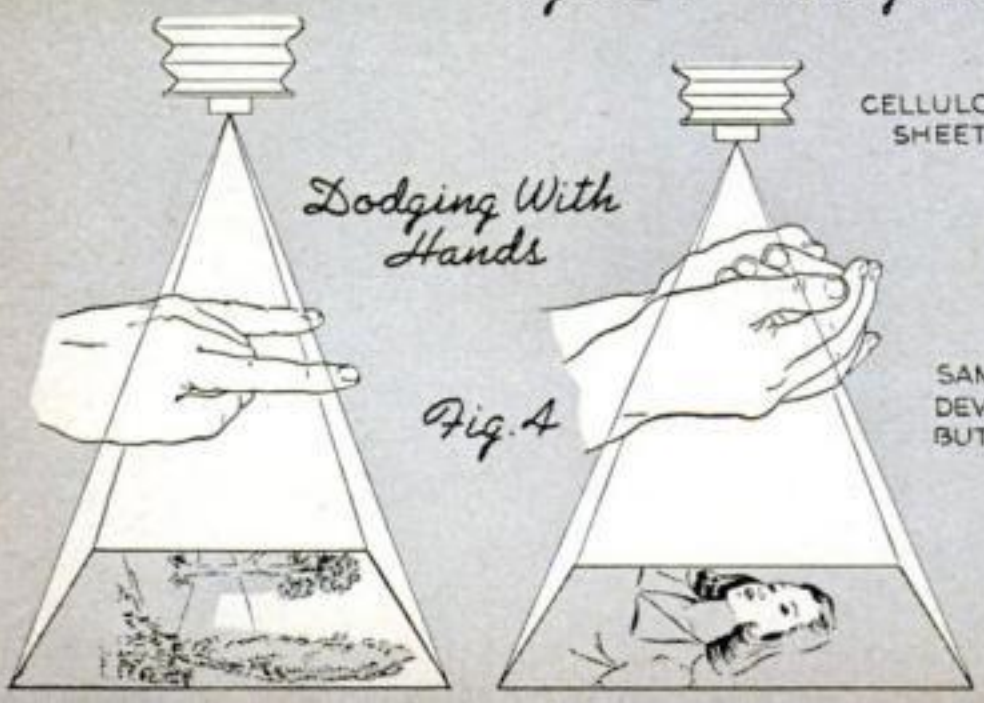


Fig. 3 Dodgers



Dodging With Hands

Fig. 4

Fig. 5 Diffuser

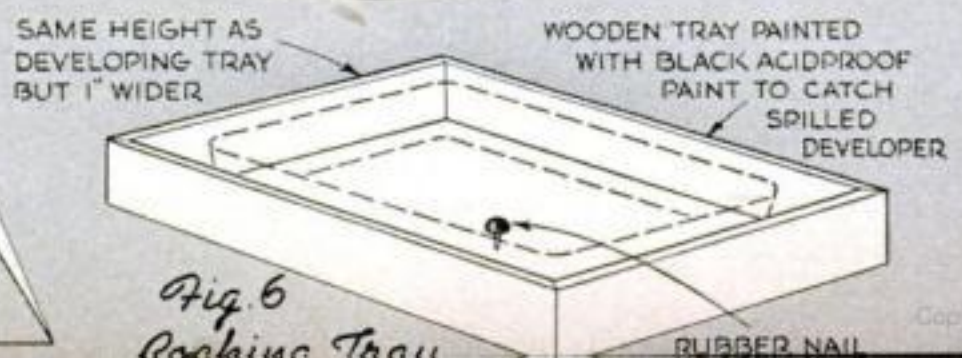


Fig. 6 Rocking Tray

ment with too many kinds, grades, and surfaces of paper. Hard, normal, and soft glossy are all you need. If you have the courage to use glossy paper, you will not only obtain the longest tone range, but you will know for certain when you have a good print. Too many indifferent photographs are made to appear better than they really are by the use of unphotographic means such as fancy surfaces of paper. The surface of a good photograph should remain absolutely impersonal. White paper stock gives the longest tonal scale. For this reason the use of other papers should be confined to times when an image has to be made to appear better than it really is (as, for example, in commercial portraiture).

Rule 4. Don't use your developer after it is exhausted. About ten 8 by 10's are all you can expect from 32 oz. of developer.

Rule 5. Keep your developer temperature constant at 70 deg. Below 65 deg. the silver image takes on a sickly grayish-green look instead of a healthy black.

Rule 6. Keep your eye on the clock and don't remove the print until the correct developing time has elapsed. Setting an interval timer for the minimum developing time is helpful to force yourself to develop your prints fully. Remember the finest qualities in a print appear toward the end of the maximum developing time.

Rule 7. Learn printing from a good normal negative. Save difficult ones until you have experience and judgment.

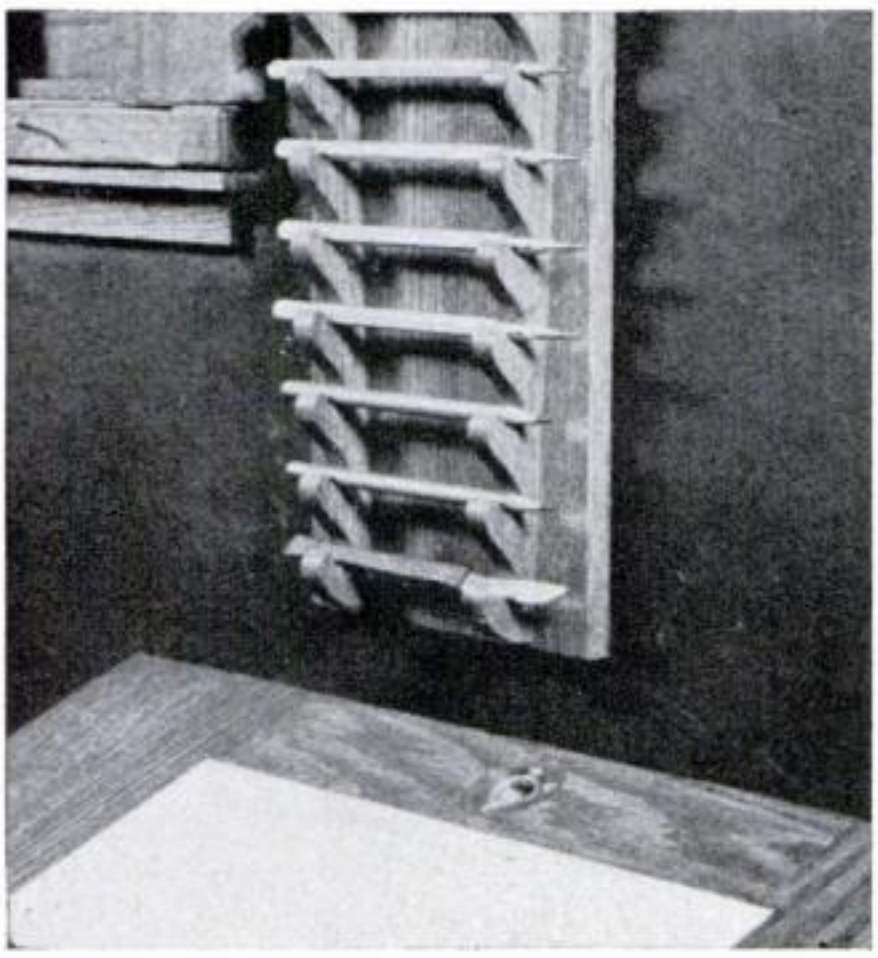
Rule 8. Thou shalt not take a good, sharp photograph and try to make it appear like a drawing, an etching, or like anything but a good photograph.

Rule 9. Thou shalt not take too great advantage of tilting the easel to produce distortion. No fair making a fat man fatter, but it is good business to do the opposite.

After the developing process has been completed, the print is quickly immersed in a second tray filled with a stop bath:

Water	950 cc.
28% acetic acid	45 cc.

The use of this bath is highly recommended, as it helps to extend the life of the hypo bath, which is the last bath into which the print is placed before it is washed. Remember, to make a good print is not easy, but the pleasure derived is worth the effort.



Wooden Rack on Wall Holds Retouching Accessories

RETOUCHING brushes and pencils can be kept at hand on this 18" by 4" wooden rack hanging conveniently near the retouching stand. The one illustrated was made of ½" oak. The two scroll-sawed strips were spaced 3" apart at the lower end for short pencils, but slant apart to the full width of 4" at the top.

Potato-Ball Spoon Saves Time in Weighing Chemicals

SMALL quantities of dry photographic chemicals may be weighed more quickly and easily with the aid of one of the small hemispherical spoons commonly found in kitchens where they are used for making fruit or potato balls. There is a tiny hole in the bowl of the spoon which will permit the chemical crystals to run through slowly and evenly to the measuring pan until the scale strikes a balance, and then a slight twist of the spoon will shift the residue to one side and stop the flow instantly.—CHARLES H. COLES.

Chemical crystals flow from the spoon until it is tilted so that the hole is no longer at the bottom

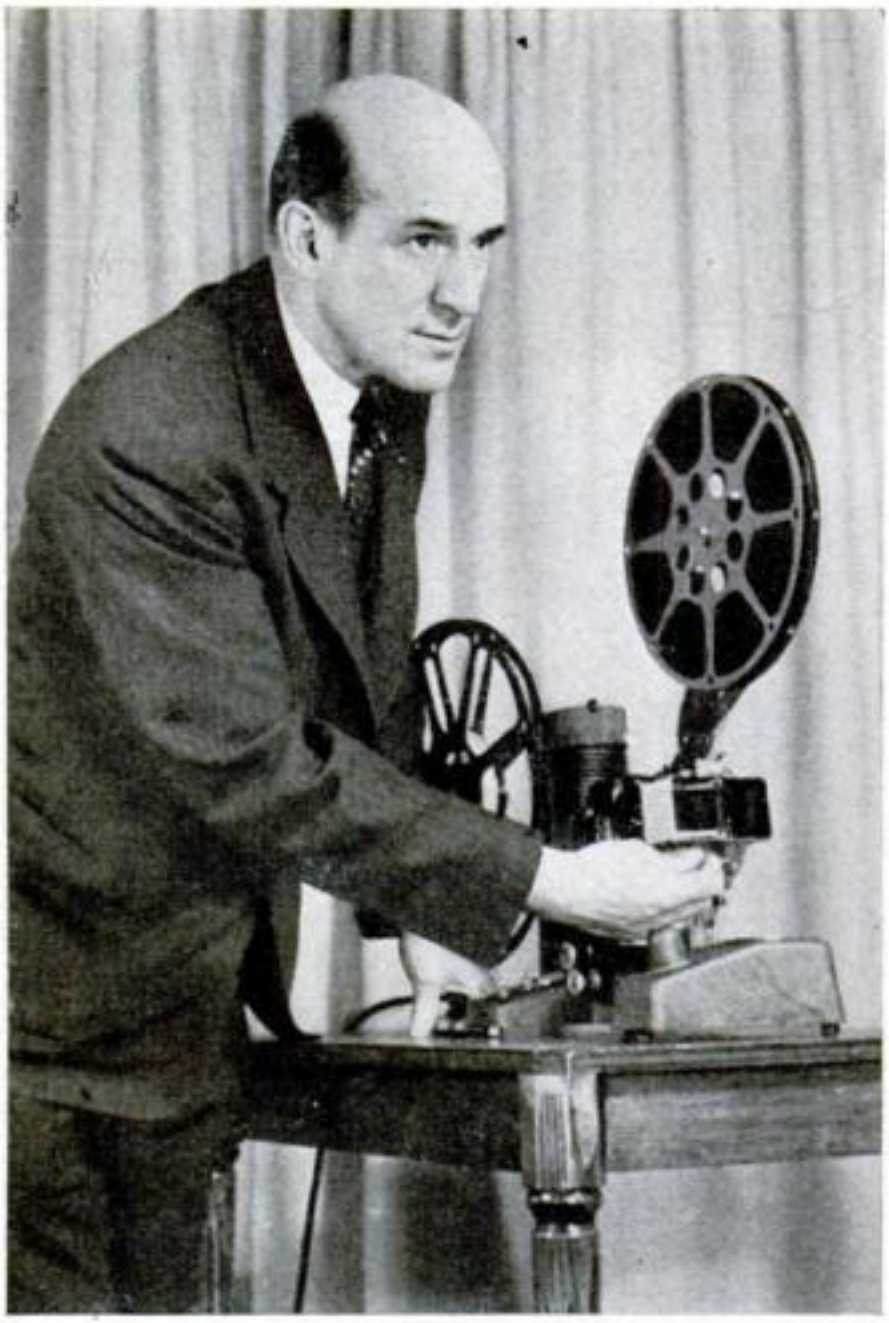
Movie Man

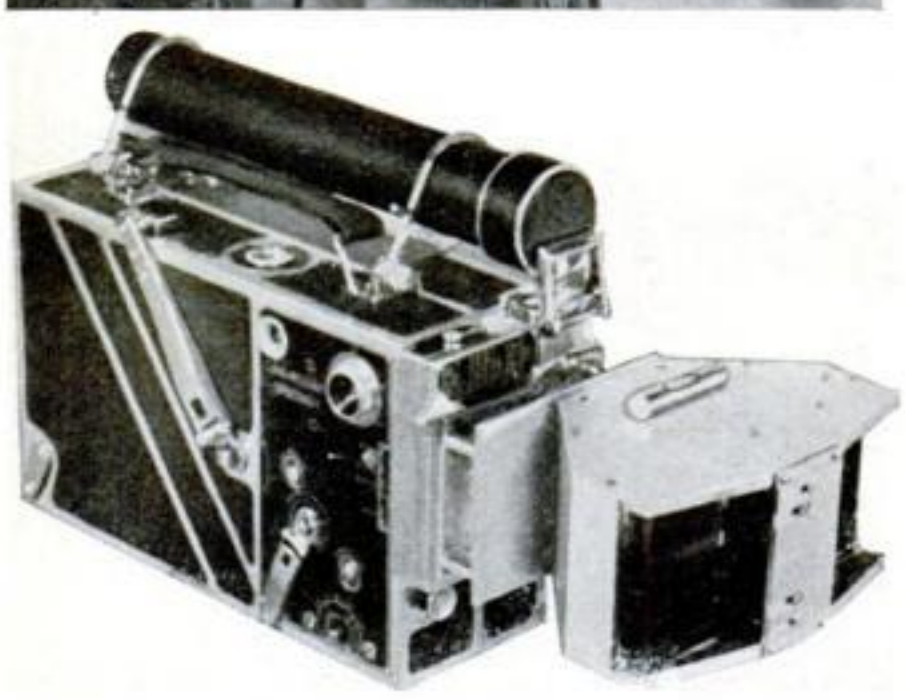
By WALTER HOLBROOK

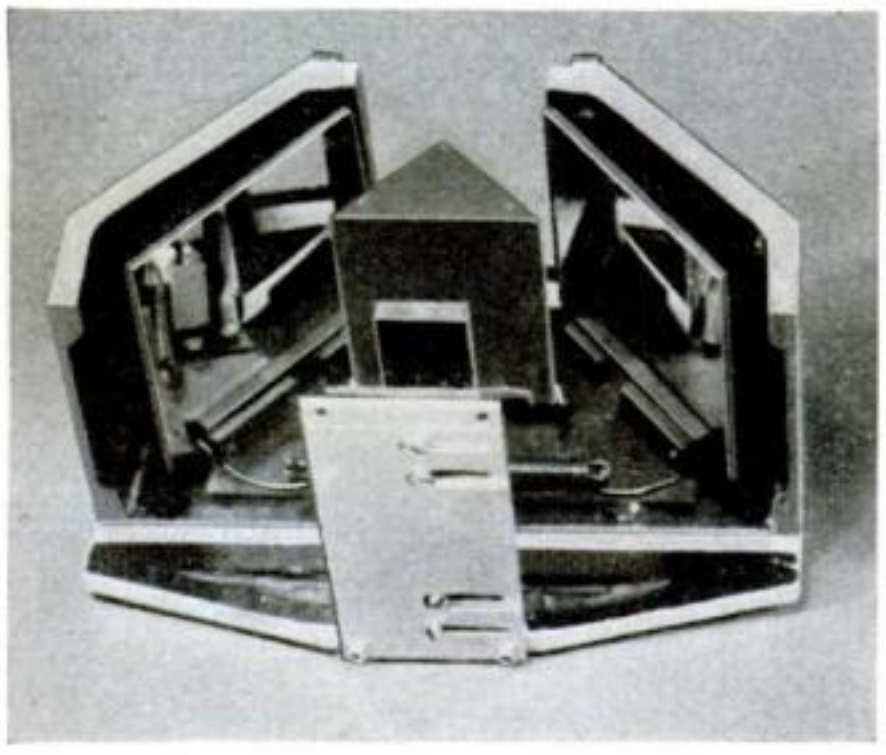
FLOYD ABNER RAMSDELL does not call himself an inventor, yet in the 25 years during which he has been producing industrial movies, he has merited the name again and again. Born to the Yankee tradition of helping oneself, the general manager of the Worcester Film Corporation, of Worcester, Mass., is constantly devising new and startling gadgets that he needs in his work and cannot buy.

The Connecticut State Health Department wanted a color movie of living germs. Anyone who has taken photomicrographs in color knows how hard it is to measure the light intensity. Instead of wasting time and film shooting by hit-and-miss methods, Ramsdell called in his brother-in-law, a radio engineer, and with his help built a photometer that reads through the camera lens and is, Ramsdell claims, 1,000 times as sensitive as any he could buy. The device is also useful in telephoto work.

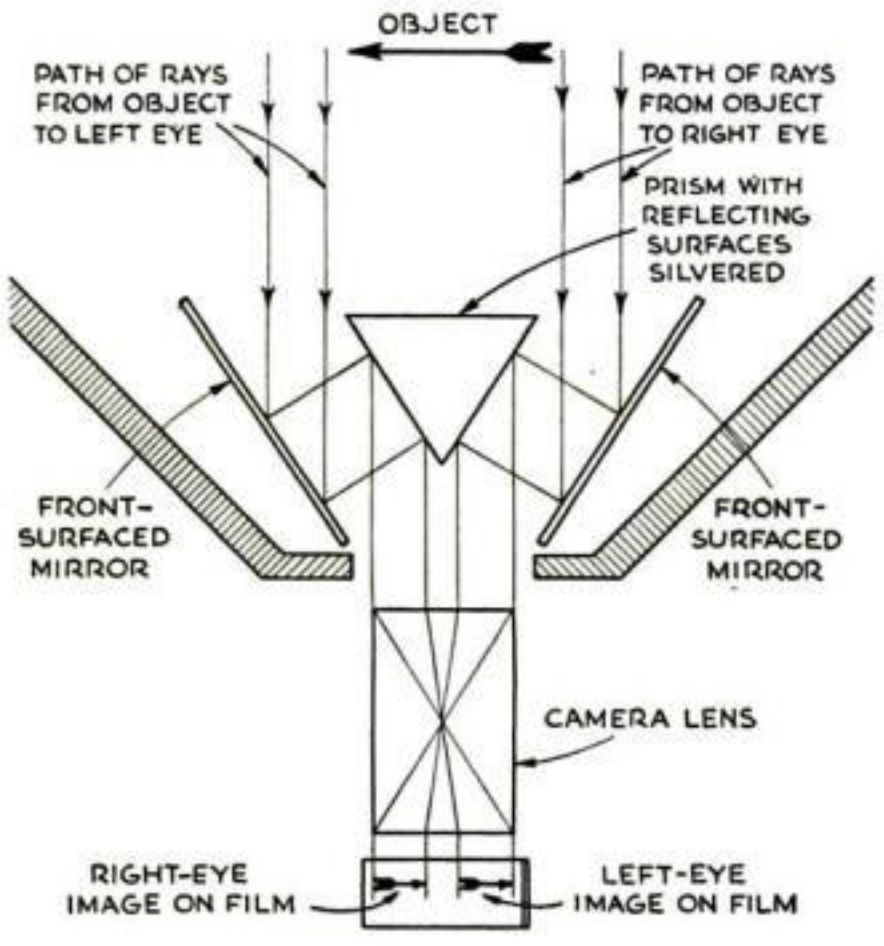
Movie "wipe-overs," in which one scene pushes another off the screen, are made easily in an optical printer, but this method cannot be used with Kodachrome film. When







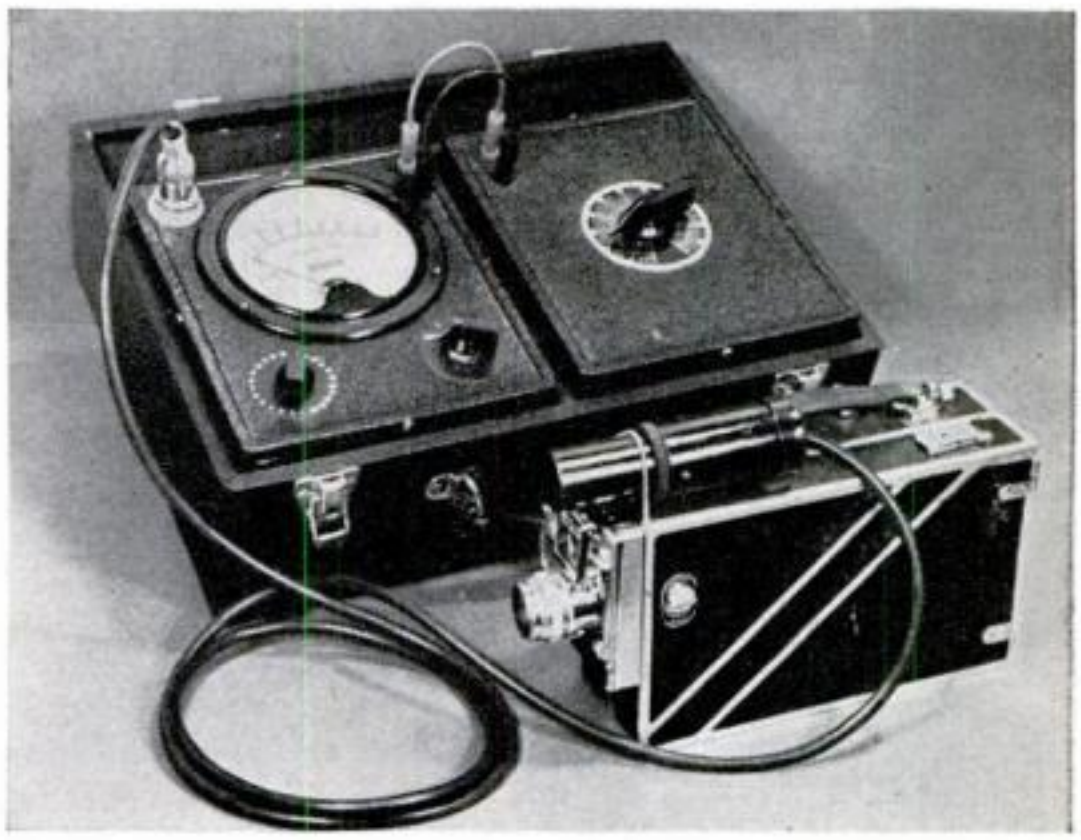
At left above, Floyd Abner Ramsdell operating a projector equipped for showing three-dimensional color movies. Directly at left, a small motion-picture camera fitted with a beam splitter, and, below it, the splitter itself. The diagram shows how it forms separate images side by side on film



Invents Curious Photo Gadgets

Ramsdell decided that he wanted Kodachrome wipe-overs, he got them with an attachment that works inside the camera.

Just as quietly, he has now developed a method of making three-dimensional movies in color, including undistorted close-ups. We have, of course, had stereomovies for 30 years. The early ones were made with one image on green film and one on red. These, when viewed through red and green eyepieces, appeared black and white, and afforded a three-dimensional effect. Certain current novelty shorts are still produced in this way, but more than one reel is literally a headache to most spectators.



To obtain accurately exposed color microphotographs, Ramsdell invented this photometer, which reads through the camera lens

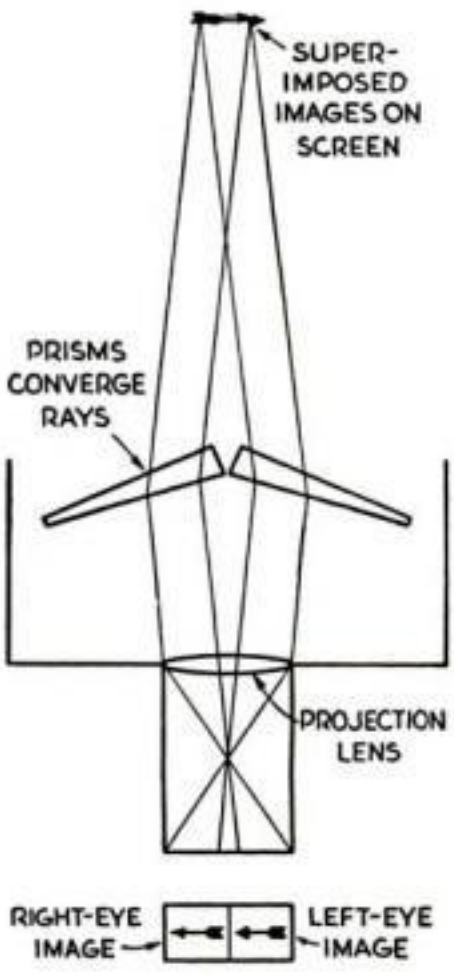
Looking for a way to convey two images to the eyes of the beholder with less likelihood of eyestrain, the Polaroid Corporation, about 1937, devised a beam splitter that enables the camera to take twin pictures from slightly different viewpoints and record them side by side on one film. Projected through Polaroid screens and viewed through Polaroid eyepieces, the two images merge into one three-dimensional picture.

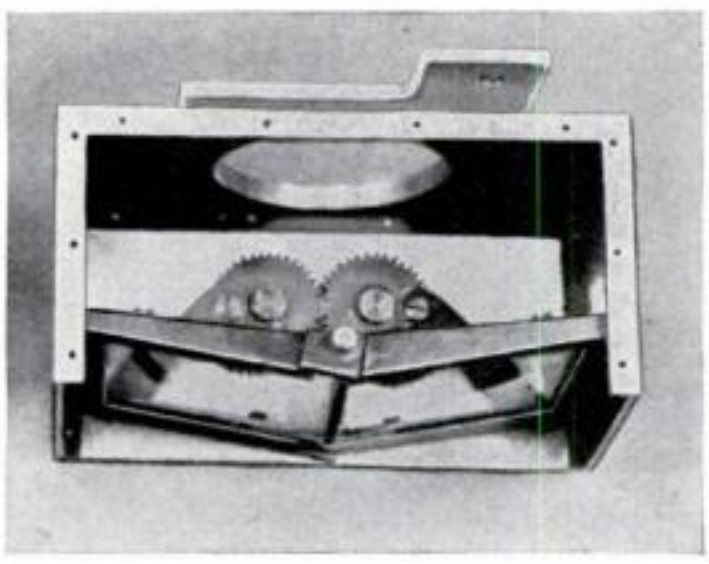
However, when Ramsdell attempted to make for a large abrasives manufacturer a stereoscopic color film to be used in training salesmen, he found he could not get close-ups without distortion. Obliged to produce the picture in two dimensions only, he afterwards started work on a beam splitter of his own.

The two apertures of the one he had been using were 5½" apart, whereas the distance between human eyes is about 2½". Distortion due to the beam splitter was not noticeable in medium and long shots, but in close-ups it produced the same effect as seeing ordinary movies from too far to one side of the screen. Furthermore, the two images were not always identical in size, and one side of the beam splitter passed more light than the other, so that a really sharp stereoscopic image or good color effects were impossible.

Early in 1940, Ramsdell devised a new beam splitter of 2½" interocular distance and had it built by an instrument maker. "Peculiarly enough," says the modest inventor, "it was satisfactory from the first, and we have been using it ever since." The diagram on the facing page shows the path of light through the device.

For a time he used the beam splitter on the projection machine to merge





Above, the converging prisms that, when placed in front of the projection lens, blend the two film images on the screen

Both beams pass through polarizing filters, omitted in the diagram for the sake of clarity, before they are superimposed

the two images on the screen, but finally had a pair of prisms mounted in a simpler attachment that fits in front of the projection lens. Each beam passes through a Polaroid filter, and the onlooker must wear Polaroid eyepieces.

With these attachments, Ramsdell can fill the screen with an undistorted image of a tennis ball. Because all beam splitters divide the picture frame into two vertical halves, the shape of which restricts movement too much, he masks off the bottom of both frames, thus preserving the original proportions.

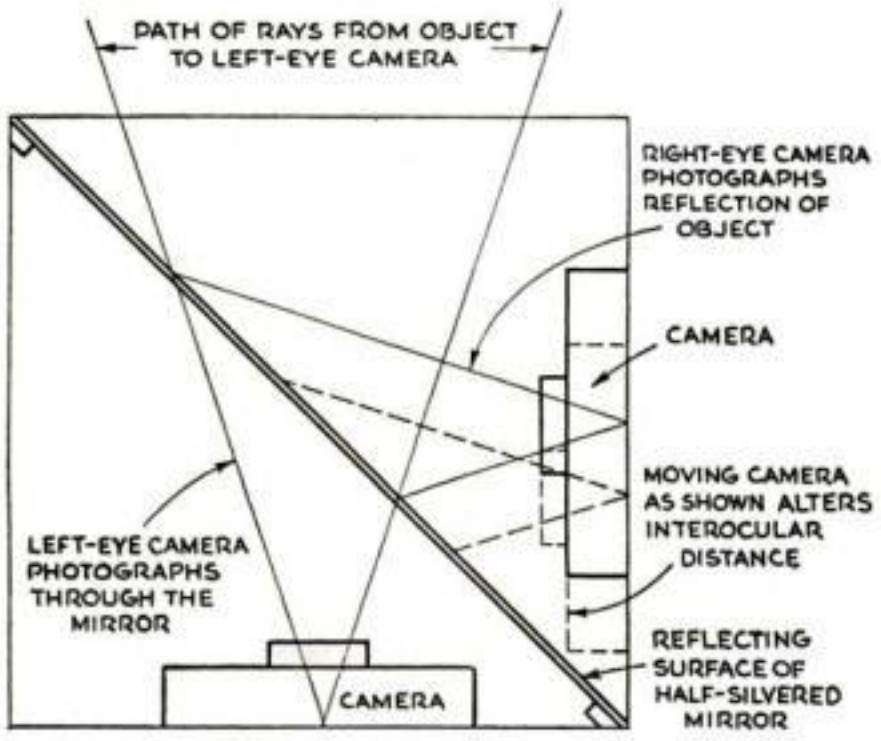
Ramsdell's inventive career began about 1915, when he designed a simplified projection machine. As sales manager for a small company making industrial movies, he made his first industrial film, *King Carelessness,* in 1916 while the head of the firm was ill.

Early in 1927, when many minds were working to perfect sound pictures, Ramsdell agreed to make one for the Boston Edison Company contrasting the inconvenience of an old-fashioned kitchen with the time- and labor-saving possibilities afforded by a compact electrical kitchen. For this purpose, the housewife had to be photographed moving about, but up to that time characters in sound films were all but chained to the microphone. Ramsdell scattered several microphones around the kitchen, learned to integrate their outputs, and was able to show a lip-synchronized movie some months before Hollywood rocked the country with *The Jazz Singer,* the first talking picture made by the film colony in which the characters moved about the sets freely.

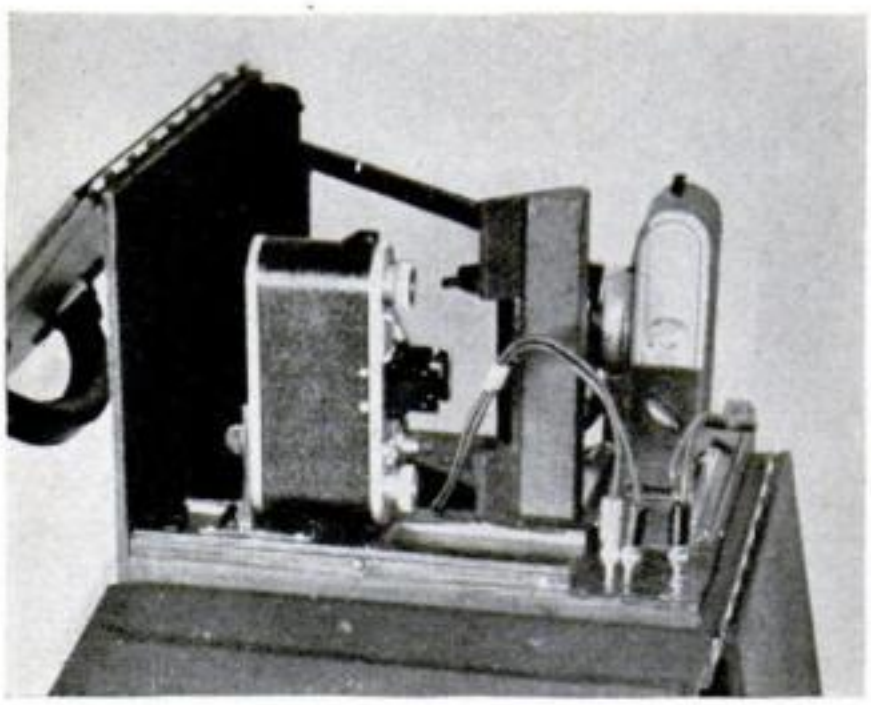
Shortly before Ramsdell designed his moving-picture beam splitter, he invented a three-dimensional still camera for taking extreme close-ups without distortion. He found that for this purpose it was essential to have the lenses even closer together than human eyes usually are. A half-silvered mirror he saw in a children's hospital suggested the solution. The mirror in question permitted doctors to observe the children while themselves remaining unseen.

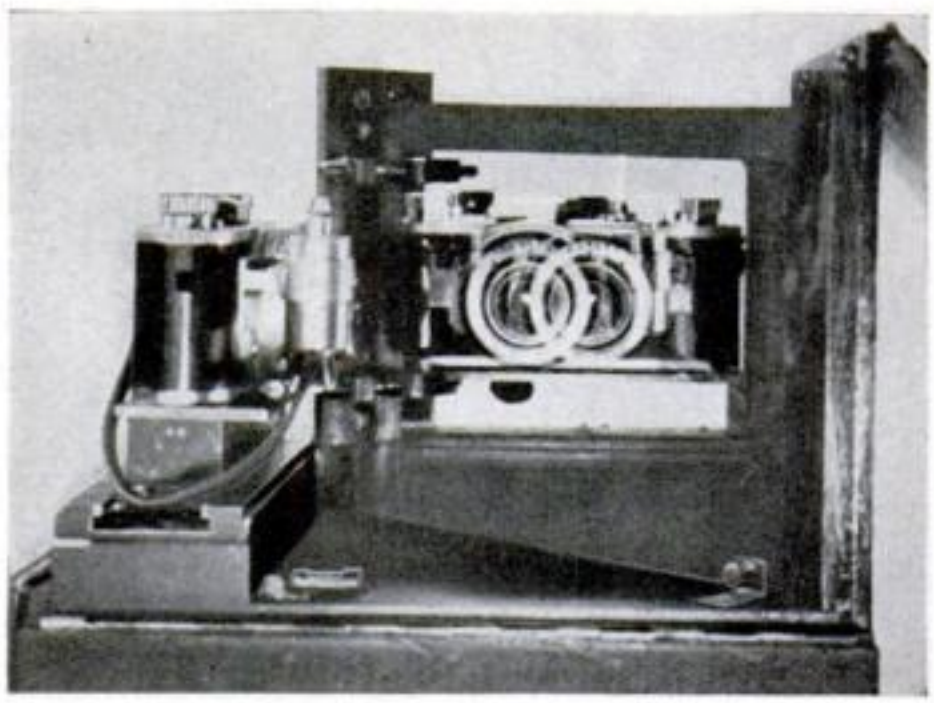
Ramsdell mounted two cameras at right angles to each other, and bisected the angle with a partially silvered mirror. Thus one camera shoots through the mirror; the other photographs the reflection of the object in the mirror. By moving one camera, he can in effect bring the lenses as close together as he pleases. According to his photometer, 34 percent of the light is lost, 33 percent is reflected into one camera, and 33 percent passes through the mirror into the second camera. As the plastic mirror he uses is unbelievably thin, it causes no appreciable distortion of the light passing through it.

Ramsdell has made no attempt to market his various inventions, believing that they have served their purpose in improving his commercial films.



The interocular distance of two still cameras in the set-up below can be varied as shown in the diagram. Both are at an angle of 45 deg. to the semitransparent mirror. At right below, the arrangement seen from the front. Apparent displacement of the lenses shows their optical positions



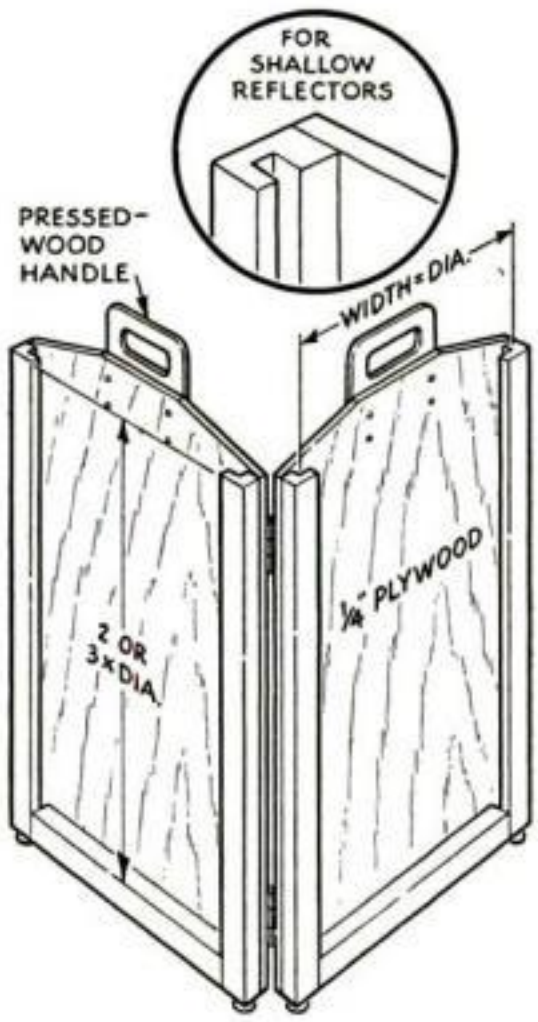


Bulky Photoflood Reflectors Carried Easily in Folding Plywood Rack

THE handling of photoflood reflectors in the studio and on location is simplified by the use of a combination carrying rack and stand constructed of plywood. Cut two panels to size to take two or three reflectors each, and attach at each of the long edges a strip of molding rabbeted or grooved to fit the reflector rims. Place a solid stop at the lower edge, fashion handles from pressed wood or other suitable material for the upper edge, and for feet drive rubber-headed tacks into the lower ends of the molding. The two leaves are then hinged together so that they will fold back flat.

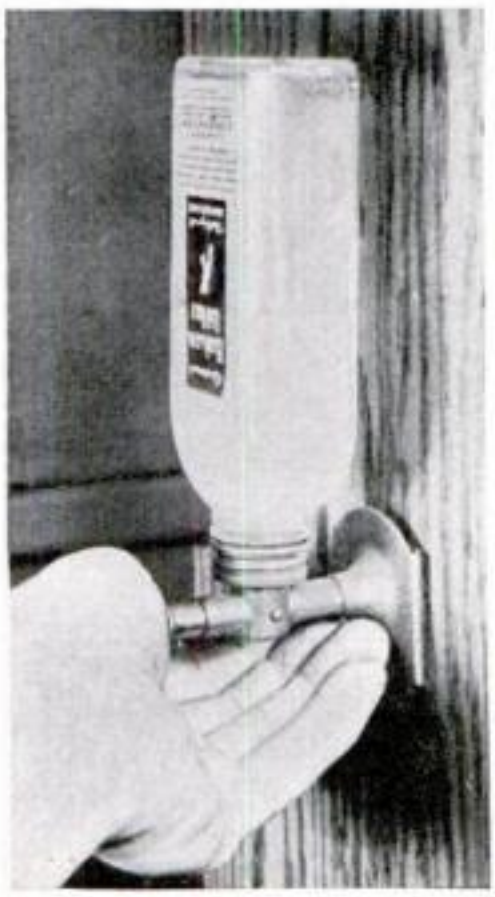
For shallow reflectors, where the bulb protrudes beyond the edge of the rim, the groove in the molding must be far enough away from the plywood panel to allow the bulbs to clear. Alternate methods of grooving are shown in the drawing.

With the leaves closed back to back, the rack may be carried with one hand. When opened at an angle, it may be set down firmly. In the trunk or on the seat of an automobile, the leaves are opened wide and the rack laid flat.—FRANK MCCARTY.

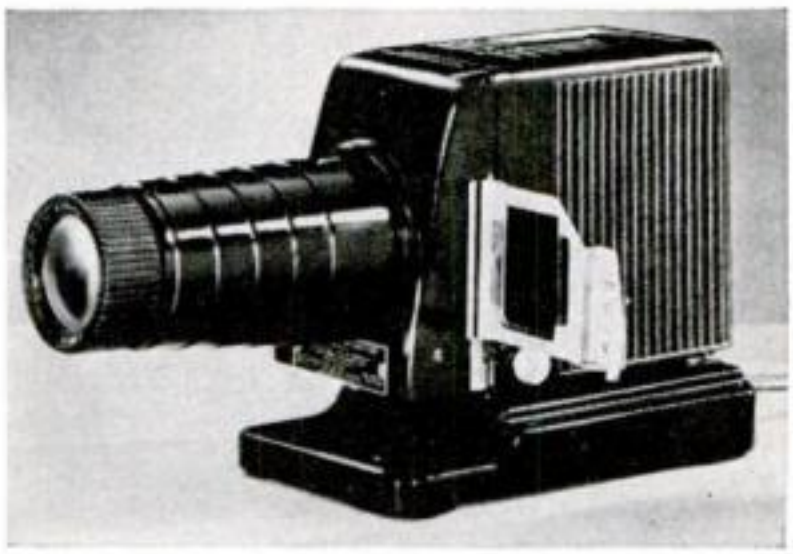


Grooved molding at the edge of the rack fits the rims of photoflood reflectors, and handles make carrying easy

Lotion Dispenser Will Keep Hands from Drying Out in Darkroom

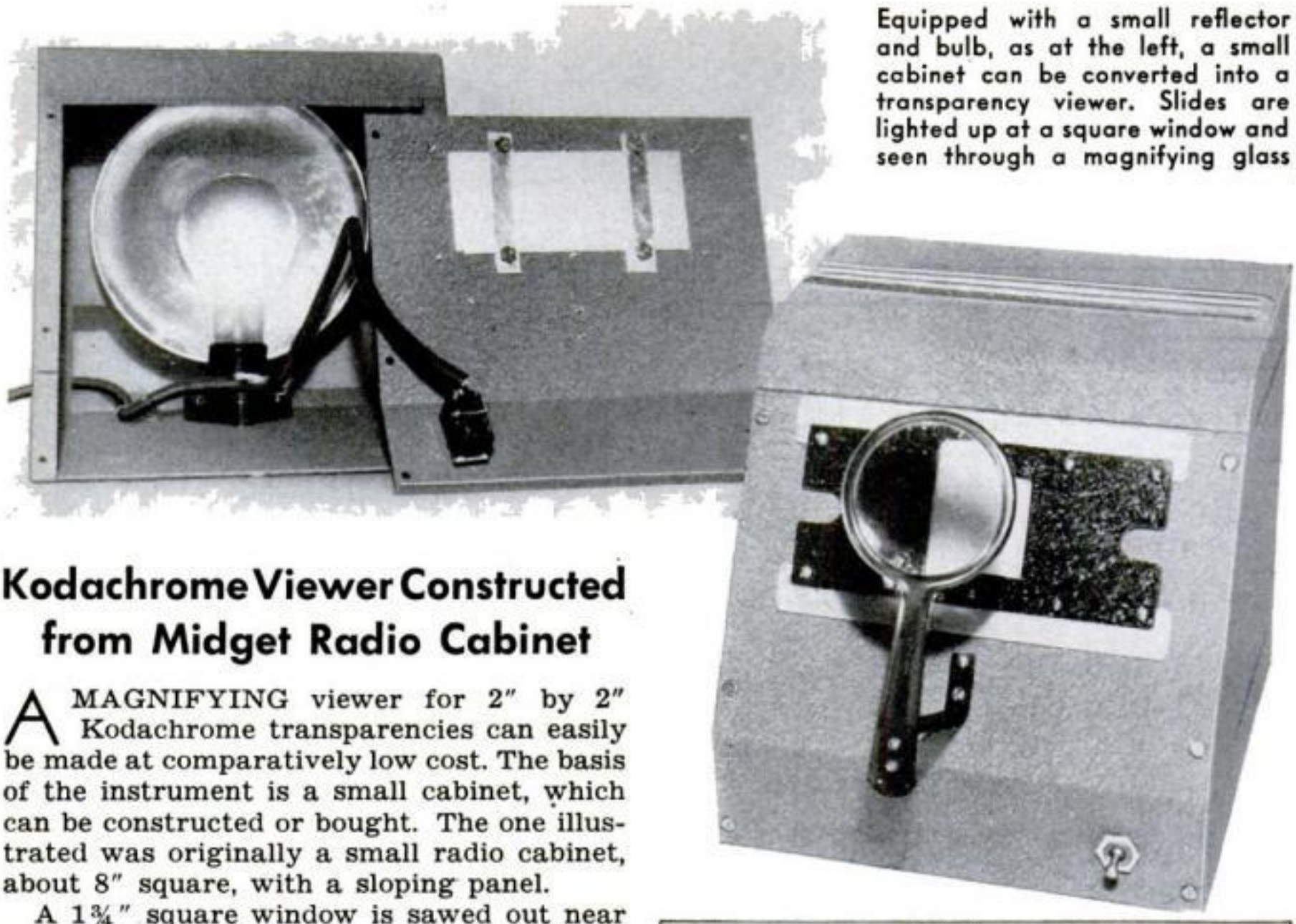


AN EASILY applied skin lotion is a help in the darkroom where the photographer's hands are likely to become dry and cracked from constant contact with the hardening-fixing bath. An ordinary soap dispensing fixture, if one is available, may be installed on the wall, and the lotion bottle attached to it so that a slight pressure will release a few drops into the palm occasionally for a quick rubbing.—C. C.



Small Projector Designed to Show Color Slides

FOR the projection of 2" by 2" Kodachrome transparencies, a small new projector is available with a 5" f/3.5 lens or a 7½" f/4.5 lens. Its design provides for control and dissipation of heat from a 150-watt lamp, and a heat-absorbing glass protects the slide from any possible damage.



Equipped with a small reflector and bulb, as at the left, a small cabinet can be converted into a transparency viewer. Slides are lighted up at a square window and seen through a magnifying glass

Kodachrome Viewer Constructed from Midget Radio Cabinet

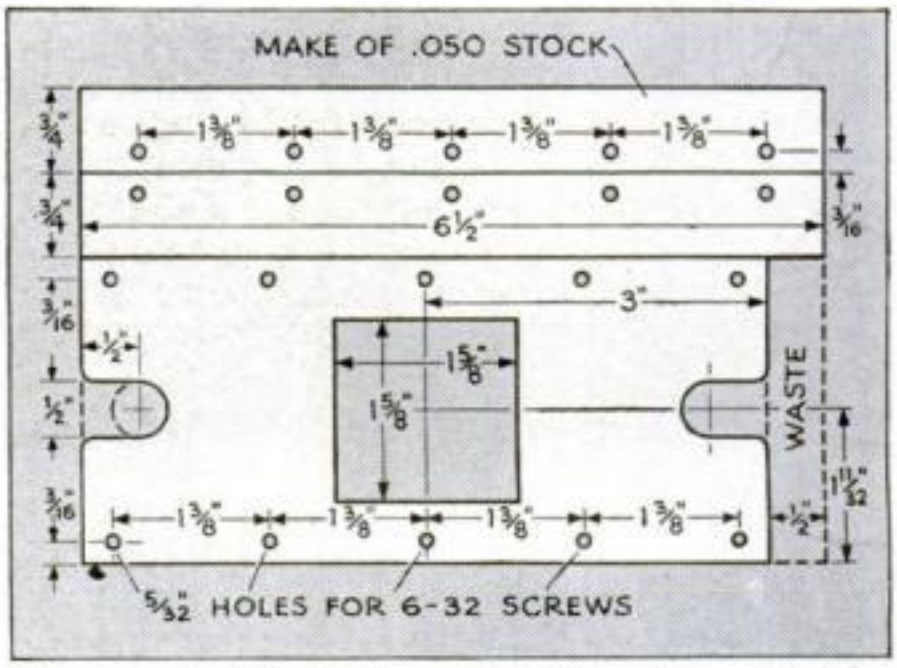
A MAGNIFYING viewer for 2" by 2" Kodachrome transparencies can easily be made at comparatively low cost. The basis of the instrument is a small cabinet, which can be constructed or bought. The one illustrated was originally a small radio cabinet, about 8" square, with a sloping panel.

A 1¾" square window is sawed out near the top center of the panel; and a 2 11/16" by 6" slide track of thin sheet brass, aluminum, or other easily worked metal is cut as shown to fit over it. Two 6½" strips, ¾" wide, are mounted under this so as to accommodate cardboard-mounted slides. The same screws are used to hold both the face of the track and the edging strips.

Behind the window, a piece of opal glass, which may be obtained from a glazier or a photo supply house, is attached with two metal strips as illustrated. Then a magnifying glass of the largest size sold in "five-and-tens" is centered over the window on a 6" long bracket bent from heavy metal.

A lamp socket is mounted on the floor of the cabinet as far to the rear as possible, leaving clearance for a 40-watt daylight bulb and reflector. The socket is connected with a toggle switch on the front panel. Avoid using a larger bulb because it might cause the transparencies to buckle.

Slides are centered automatically as they



Layout of slide-track parts. File edges of strips as necessary to make the track accommodate slides

are inserted from either side. When the edge of the second transparency is even with the edge of the track face, the first slide will be precisely in front of the viewing window.—ROBERT EICHBERG.

Adhesive Mask Helpful in Treating Negatives Locally

LOCAL treatment of a negative, such as intensification or reduction, can be done with great accuracy by using adhesive cellulose tape as a mask. Carefully place strips of the material so as to outline the section to be treated and press the edges of the tape down firmly. Then apply the reducing or intensifying solution with a brush or cotton swab. Afterwards rinse the negative and pull away the tape, finishing by washing the negative again for a short time before hanging it up to dry. This method gives clean-cut results, without any "creeping" of the solution.—C. L.

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Gus Drives a Bargain

(Continued from page 144)

ginning to think this car may be a good one!"

"Sure it's a good one!" the salesman proclaimed. "I wouldn't try to put anything over on fellers like you and Mr. Corcoran. Well how about closing up this deal?"

Jerry looked at Gus. Gus shook his head. "Wait a while," he advised. "Let's take a little ride out in the country."

Benny glanced at his wrist watch, and for the first time looked worried.

Out on the open road Gus speeded up to forty. Then he suddenly took his foot off the accelerator. The car slowed abruptly, but there were no knocks or raps. "That tells the whole story, don't it?" Benny demanded. "If there's a bad bearing, or anything like that, doing that to a car shows it up. Say, gents, I've got to get back—"

Ahead of them there was a long, easy upgrade. When they got to the bottom of it Benny began telling a funny story. He talked loud, and he laughed louder all the way up the hill. He did his best, but he didn't make enough noise to keep Gus from hearing a dull thudding in the engine.

When they got to the crest of the hill he again suggested that they turn back. "Just a little farther," Gus said. Another hill loomed ahead of them. Benny started another story. "No use," Gus told him. "You're wasting your breath. Listen, Jerry." The dull thudding seemed louder.

Gus turned the car and headed for home. For a while the salesman didn't say anything. Then he looked at Jerry. "First time I've heard that noise," he said. "Sounds to me like the crankshaft."

"It does sound as if it was somewhere near the crankshaft," Gus said. "Maybe . . ."

"I tell you what I'll do," Benny broke in hastily. "I'll knock fifty bucks off that price. How about it?"

"I dunno," Jerry said, looking at Gus.

"Take it," said Gus.

Back at the shop, Jerry got Gus aside a minute and asked: "How about that crankshaft Gus? won't it cost more—"

Gus laughed. "Benny's a sharp guy, but he isn't much of a mechanic," he said. "He probably thinks that the crankshaft is shot. What is wrong is that there is a little too much end play in it. It isn't bad, and probably it'll never give you any trouble. I can fix it, but it won't cost any fifty dollars. Benny's outsmarting himself. Here he comes."

"You've got a bargain," Benny smiled.

"Well," Gus said, "a bargain's a bargain—wherever and however you get it!"

"LIFE WAS SLIPPING THROUGH HIS ICY FINGERS!"

A true experience of special policeman FRANK HAHNEL, *New York, N. Y.*

"IT WAS STILL DARK...and bitter cold on the waterfront...when I finished my night patrol," writes Mr. Hahnel. "I had paused for a moment to say hello to a couple of friends when above the dismal sounds of the river came a piercing shriek and a heavy splash. Then there was silence.

"WE RUSHED FOR THE WHARF. I yanked out my flashlight and turned it on the water. There in the icy river 14 feet below we saw a man struggling feebly...clawing at the ice-sheathed pilings as the out-racing tide sucked him away from the pier.

"QUICKLY I DARTED my light about and located a length of line on a nearby barge...and a life preserver on an adjoining pier. In an instant the preserver splashed in the water beside the drowning man. Dazed from shock and cold, half clinging to the preserver and half lassoed by the line, he was dragged to safety. Thanks to my 'Eveready' flashlight and its dependable *fresh* DATED batteries the river was cheated of its victim. *(Signed)* Frank J. Hahnel"

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UCC

Testing the Hot Ships

(Continued from page 57)

danger of their job, but of its exacting routine and the vast amount of information a man must keep continually in the front of his mind. It is all very well to fly many different types of planes, but any man who has tried to find the self-starter in a strange car will realize how easily an aviator can go wrong. The cockpit of a little pursuit plane is a complicated maze of dozens of dials and controls, while in a four-engine bomber the number goes up in the hundreds, all of which the pilot must have in mind. And they are not the same on different planes. The test pilot must spend hours a day studying the ships he intends to fly.

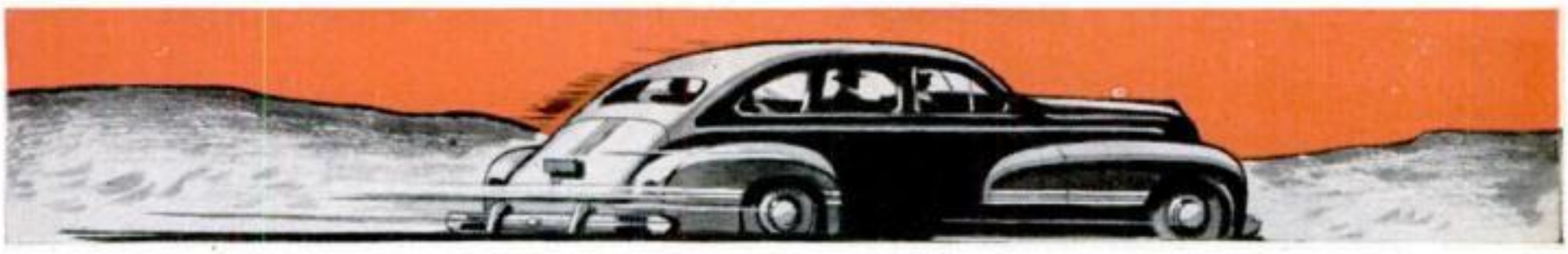
The test flyer of a dozen years ago got into a plane, opened the throttle wide, and took off, to fly largely with his skill and instincts. He had no retractable landing gear to bother with, no flaps to lower, no variable-pitch propeller, no supercharger, no manifold pressure to watch, no radio. He landed at slow speed. Each one of these improvements means just so much more the pilot must have in mind.

The standard performance test for military planes is composed of 17 items, designed to explore precisely every potentiality of the ship, both as data for further development and for guidance of the pilots who will operate the model in service. The test pilot must turn in a report in which human error is practically negligible. Two good pilots, testing the same plane, will turn in results which are nearly identical.

A fundamental testing process, for instance, is the calibration of the air-speed meter. Timed by a stop watch, the pilot makes five two-way runs over a measured course at an altitude of only 25 feet, keeping altimeter and speed readings quite constant during each run. On the flat ground near Dayton this is quite possible on a perfect flying day, but it takes a good man to do it. In ordinary cross-country flying a man is maintaining pretty level flight if he stays within an altitude range of 250 feet. The observations made in this test, with corrections for temperature and pressure, serve as the basis for speed tests at higher altitudes.

Climbing tests are still more difficult. The basis for these are the saw-tooth climbs, so called because the barograph record of such a flight looks like the blade of a saw. The indicated speed at which a plane achieves its maximum rate of climb varies with altitude. So in the saw-tooth climb the airplane is run through a specified altitude range at

(Continued on page 222)



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You can do many things to cut the cost of operating your car. Each one keeps money in your own pocket—and conserves material for Uncle Sam.

Speaking of Spark Plugs

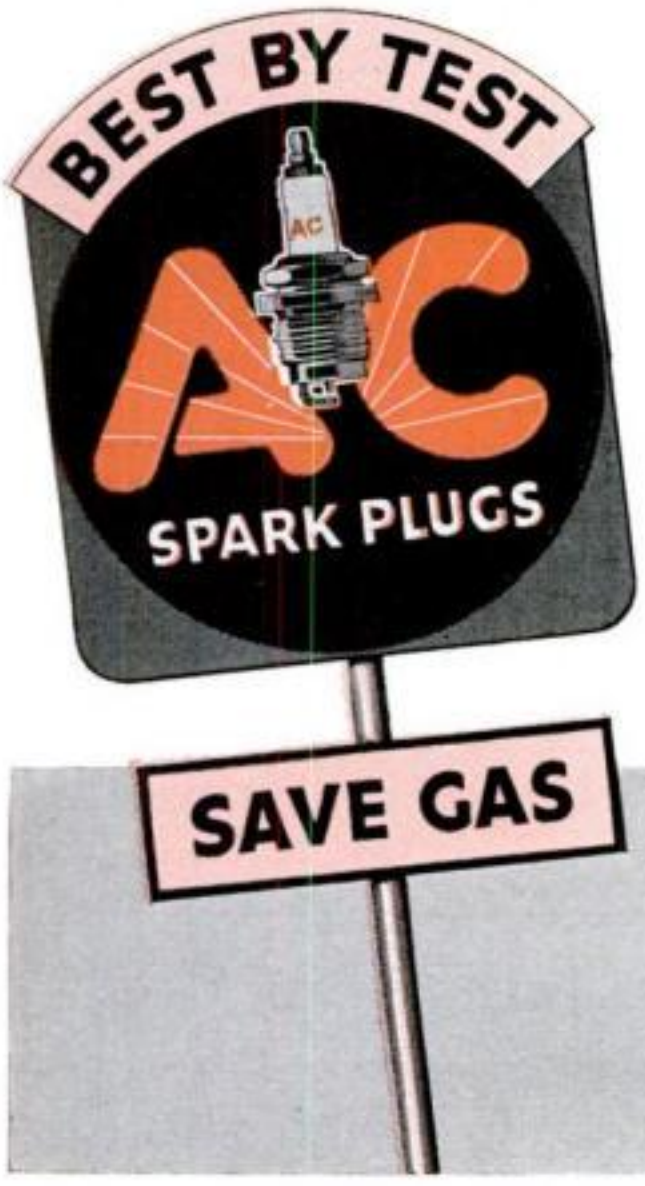
Scores of engineers' road and laboratory tests prove that dirty and worn plugs waste gas,—as much as one gallon in ten. Such plugs cause hard starting, too, which shortens the life of both battery and starter.

Here's what to do for economy:

1 *Have your plugs cleaned and adjusted every 4,000 miles.*

2 *Replace badly worn plugs promptly.*

Dirty plugs misfire intermittently because the oxide which coats them is a conductor when hot. Worn plugs misfire, especially at high speeds and under load, mainly because the spark gap is worn too wide.



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Help yourself to cut car upkeep cost—and help America, too—by giving your spark plugs this *simple,* regular care.

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AC SPARK PLUG DIVISION • *General Motors Corporation* • FLINT, MICHIGAN

Testing the Hot Ships

(Continued from page 220)

various speeds, until the most efficient one for each altitude is found.

Using the data thus obtained, the pilot is ready for his check climb, which for most men is the most difficult test of all. This is to determine the true rate of climb from ground level to the airplane's service ceiling. The pilot must climb his plane steadily from the ground, keeping his r.p.m. constant and gradually reducing the air speed in accordance with the best speeds indicated by the saw-tooth climb. Watching the altimeter closely, and flying his plane precisely all the while, the pilot at each 1,000 feet of climb must note down on his scratch pad the carburetor air temperature, the free air temperature, and the manifold pressure. Meanwhile, at low altitude he has started breathing through his oxygen mask, to store up a surplus for that high altitude where the pressure is so low that a man can't breathe enough, even of pure oxygen, to supply his needs.

Back on the ground, he plots his data on a graph. If accurate, they will fall into a smooth curve. But if any reading is out of line, he has to fly back and check it again.

The service ceiling may be 30,000, perhaps 35,000 feet. Even with improved oxygen masks and enclosed cockpits, it is still uncomfortable for the pilot at those altitudes. More and more of the test pilot's job is up at the ceiling; that is the frontier of military aviation today, and if American airplanes achieve supremacy in the battle over Europe it will probably be because of the turbo-supercharger which makes possible their efficiency at altitudes out of reach. The test pilot works up there today, and if war comes it will be a regular thing for every military pilot.

Your working test pilot is usually strained to the edge of human endurance. His flights are not skylarking, but the tour of duty does not last forever, and after two, three, or four years of this sort of thing, he has a training and knowledge of airplanes which could be obtained in no other way. The Air Corps needs men like that. From now on in his career, you might almost say, the sky's the limit.

Question Bee Answers—Page 128

1. d	2. a	3. b	4. c	5. d
6. b	7. a	8. d	9. b	10. c

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Save 2¢—stick coupon on penny post card

Metal That Never Tires

(Continued from page 63)

an experiment, a European manufacturer made a watch entirely of beryllium alloys. That watch was dropped 3,000 feet from an airplane. When picked up it was still keeping accurate time.

Beryllium-copper is soft and malleable until it is hardened by heat treatment. It can be rolled, forged, cast, or stamped into almost any useful shape. After that it can be hardened so that it will hold its shape permanently.

This curious quality is of infinite interest to the War Department. Every part of the firing mechanism of every gun, big or little, is made of steel. Every one of those parts must be rough cast, then machined and polished down to the finished form. But make a casting of soft metal, then harden it. Little polishing or machining is needed, and you save billions of man hours for national defense.

An American ordnance company recently demonstrated this. A new-model signal flash gun had to be built for the British Army. To design and construct the first model of any gun always takes months, often years. The parts of the gun were cast in beryllium-copper, and the entire job was finished in two months!

Yet even this does not begin to tell the story of beryllium's amazing versatility. Used mainly now as an alloy, the pure metal itself has vast possibilities. Experiments are in progress at the Brush Beryllium Company and elsewhere to determine if the brittleness of the metal is inherent or may be due to certain minute impurities. The pure metal is transparent to X rays, and is used for windows in X-ray machines. Physicists use it for targets in their atom-smashing apparatus.

Beryllium salts have important uses. The tube of your fluorescent lamp—the closest thing to sunlight man has produced—is coated with beryllium oxide. So is the magic screen of the new television sets. And Dr. Sawyer has discovered that, when firing kilns are lined with bricks made of beryllium silicate instead of ordinary brick, the beryllium in some mysterious way imparts strength to china.

When two years ago the public learned through Congressional hearings how important beryllium is to national defense, rumors began to spread of an impending shortage and of fabulous riches to be gained by discovering a deposit. But though the supply is not limitless and a sudden demand

(Continued on page 226)

How Atlas SERVES THE NATION

One in a series of messages showing how Atlas helps in the armament program.

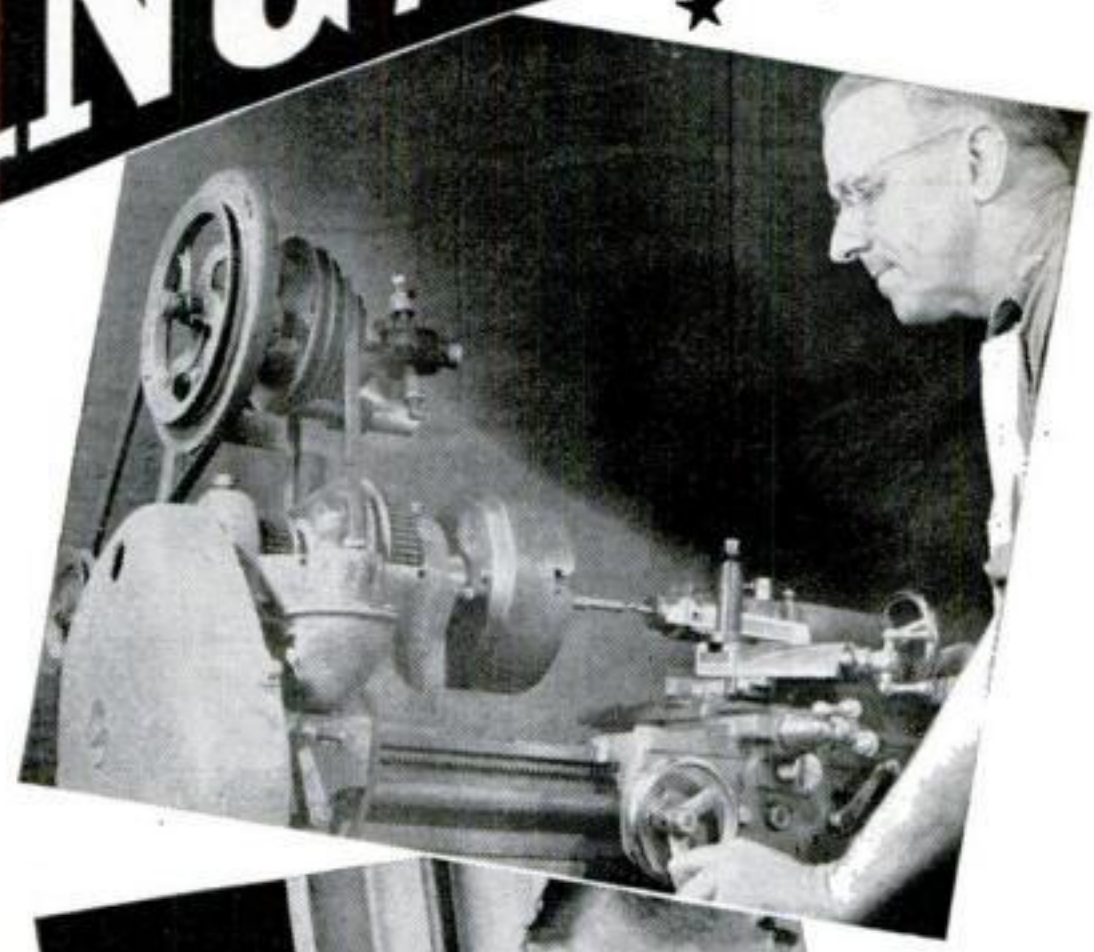
Off. U. S. Navy Photo

CORNING ANSWERS THE CALL!

". .—. ..— — — .—.. ... . —.. .— .... . .— —.."

Battleship "blinkers", airplane signal lights, beacon lights and air field floodlights — intensified by accurate lenses — are but a few of the important products of the Corning Glass Works that multiply the fighting power of our armed forces.

Hard at work in Corning's famous laboratories for research in Corning, N. Y., scientists seek still more effective uses for glass. And as in so many other key production plants, Atlas precision equipment helps share the burden. Atlas Shapers are used in making new apparatus for these laboratories and in the Mechanical Development Department Atlas Lathes machine many small precision parts.



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Metal That Never Tires

(Continued from page 224)

might create a temporary shortage, there is plenty of beryllium in the earth's crust. Most of it is in the Western Hemisphere.

Beryllium is made chiefly from beryl, a species of precious stone that includes the emerald. You can see beryl crystals in almost any museum. You can recognize them by their typical six-sided shape and their cloudy but delicate tints of rose, pink, or blue. Often they are quite long, sometimes as much as 14 feet. Smaller crystals have been picked up in New York's Central Park and larger ones have been quarried at Mount Kisco, near New York. In availability of the raw material, this country is better situated than any other.

The ore occurs in what geologists call pegmatite dikes, along with feldspar and mica. It is to be found in scattered localities on the eastern seaboard from Maine to Georgia, in North and South Dakota, Utah, Wyoming, Nevada, California, New Mexico, and Arizona. It is mined only in Colorado, but in a number of places it is reclaimed as a by-product.

Argentine and Brazil produce beryl in interesting quantities. We import over 1,000 tons annually from these countries. They used to supply Germany before the war. Now Germany has to depend on a single deposit in Austria—a little-advertised reason for the *Anschluss*. But there are abundant supplies in Russia's Ural Mountains.

Beryllium is still expensive. The small amount handled and the cost of reducing it keeps the price high. As beryllium takes over more and more of the work of industry it will unquestionably come down, as it has already come down from $200 to $15 per pound since 1929. With greater efficiency both at mine and factory, experts say it can be produced in quantities at between $1.40 and $2.70 per pound. Beryllium production doubled in 1940 and again this year.

The entire field of research in this metal holds latent marvels. Today, for instance, beryllium is used chiefly with copper. But beryllium-nickel has all the properties of beryllium-copper in far greater degree. Germany is far ahead of this country in the production of beryllium-nickel, a field in which we have serious technical difficulties to overcome.

So beryllium, tireless worker of silent miracles, still has its future ahead of it. What surprises that future may hold can no more be imagined than Fulton could have visualized an airplane operated from the ground by radio.

How "Quality" is Built into DELTA 6" JOINTERS

Here's the story of the unseen "hidden" quality that is built into one Delta machine — a story typical of the entire line of Delta machines.

EXTREME accuracy is a vital necessity in building satisfactory jointers. If the tables of a jointer are out of alignment by as little as *five thousandths* of an inch—this can make a piece of work only 3 feet long a full 1/16" narrower at one end than at the other! This is impossible with Delta Jointers because of the special precision grinding of the tables. The tables of the jointers are first rough machined singly. The entire jointer is then carefully assembled with the **tables mounted on the base—and both tables are then accurately ground at the same time on huge, ex-**

pensive surface grinders (illustrated above) within extremely close limits. The tables are then carefully inspected with special gauges (as shown in photo) to insure their being in alignment and absolutely parallel. This is but one of many processes used in building Delta Jointers to assure you of the dependable accuracy that has become synonymous with the Delta name.

MANY OUTSTANDING FEATURES

make this the finest 6" Jointer available. These include: Heavy Cast Base and Tables; Tables carried on Gibbed Dovetail Ways; Patented Tilting Fence; Patented Automatic Stops; Free-Swing Dual Control; Depth of Cut and Tilt Scales; Double-Seal Ball Bearings, Lubricated for Life; Front Safety Knife Guard; Safety Type Head with 3 High-Speed Steel Knives.

Send for Delta Catalog

Write for the new Delta catalog which is a complete guide book to power tools. It not only lists the entire line of Delta "Quality" wood and metal working tools—but shows you the important points to look for in all power tools. It illustrates and explains the advantages of the many hidden features of design and construction that make for long, better service in power tools. (Also send for Project Book No. 8 crowded with new projects, including working drawings, photographs and full instructions.)

DELTA
MILWAUKEE

The Delta Manufacturing Co., (Dept. 683-B)
600-634 E. Vienna Ave., Milwaukee, Wis.

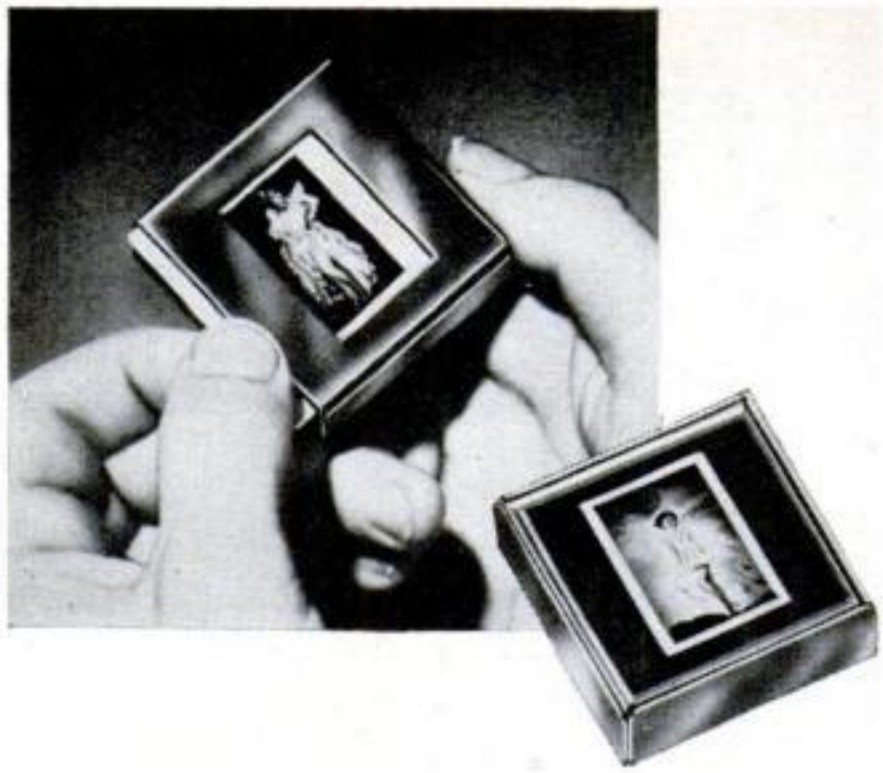
Gentlemen: Send me the latest Delta Catalog listing the complete line of Delta Lathes, Circular Saws, Band Saws, Jointers, Scroll Saws, Shapers, Sanders and Drill Presses.
☐ I enclose 10c (stamps or coin) for which please send me the new Delta Project Book No. 8

Name .....

Address .....

City ..... State.....

☐ Check here if you are a Delta user now.



Two New Viewers Light Up and Frame Color Shots

TWO viewers that light up and frame Kodachromes have been developed by the same manufacturer. Each comes with batteries, bulb, and diffusing system, and is small enough to carry in a pocket or purse. One, incased in a mirror finish, frames a slide semipermanently and is suitable for a transparency one might care to look at frequently. The other has a reservoir on the underside for holding from four to six slides, which may be slipped into the frame for viewing without lifting the cover.

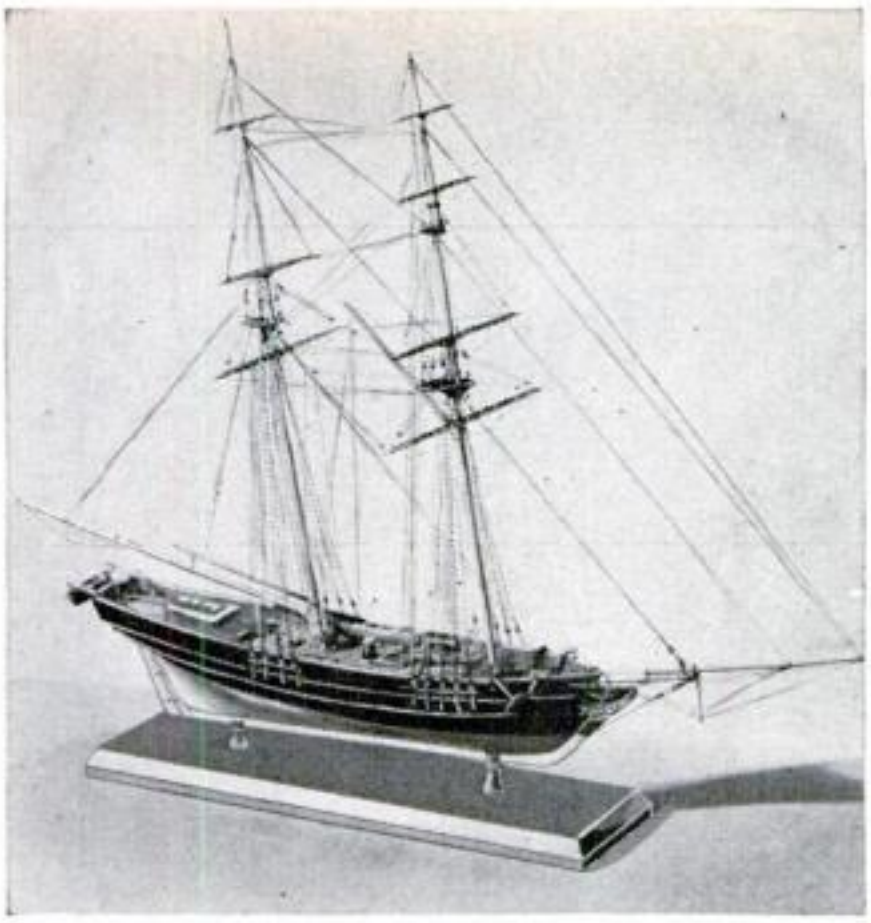
Pocket Synchronizer Contains Batteries and Reflector

Only 3" by 2¼" by 1", the synchronizer is used with any cable-release camera

THIS pocket synchronizer, little larger than a pack of cigarettes, comes complete with flash batteries and reflector, and attaches to the tripod socket of any camera equipped with a cable release. The stainless steel reflector is polished to a mirror finish.

• • •

FASTER film for so-called "double-eight" movie cameras has been introduced under the name "Twin-Eight Triple-S Pan Reversible." It is especially recommended by the maker for action shots or for interiors with unfavorable lighting.



Unusually Complete Kit Builds Square-Rigged Slave Ship

MANY of the grim vessels that ran slaves from Africa to the new world were built expressly for that purpose in American shipyards. Sharp, clean-cut lines gave them the speed so essential in their illegal trade, and the beautiful model of the *Dos Amigos,* illustrated above, shows these off to full advantage. It is 25" long overall, 25" high, and scaled 3/16" to the foot. Our new kit No. 15S includes a precision-shaped, hollowed hull, all deck and spar materials, rigging, complete plans, instructions, and over 350 *finished* fittings. It is shipped prepaid to any address east of the Mississippi River for $14.00; the price west of the Mississippi is $14.50.

Other kits for whittled projects, simplified ship models, famous sailing vessels, modern warships, and Colonial rooms and furniture, start at 60 cents. A stamped, self-addressed envelope will bring you our complete list of construction kits.

Popular Science Monthly, Dept. 22A
353 Fourth Avenue, New York, N. Y.

Please send me Kit.....for which I inclose $.....(or send C.O.D. ☐)

Name .....

Address .....

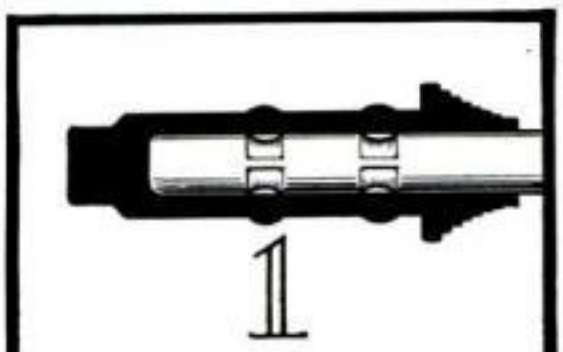
City ..... State .....

(Please print your name and address very clearly)

You save the C.O.D. charge by sending your remittance with this order. Remit by money order, check, or registered mail. This offer is made only in the United States.

Stanley Screw Driver

No. 25



1

Blade tempered entire length. Recesses forged into butt end which is driven into steel bolster . . .

2

Bosses are swaged into blade recesses. Four sharp wings are swaged on outside of bolster. Blade is now locked into bolster . . .

3

Bolster and blade are driven into handle securely by hydraulic press. Wings lock into hardwood handle so blade cannot twist.

STANLEY
Trade Mark

This patented construction makes it possible to temper the blade its entire length, providing greater strength. Stronger, better insulated, and with accurately machine cross-ground tips, the Stanley No. 25 Screw Driver is made in 8 lengths, 2½" to 12".

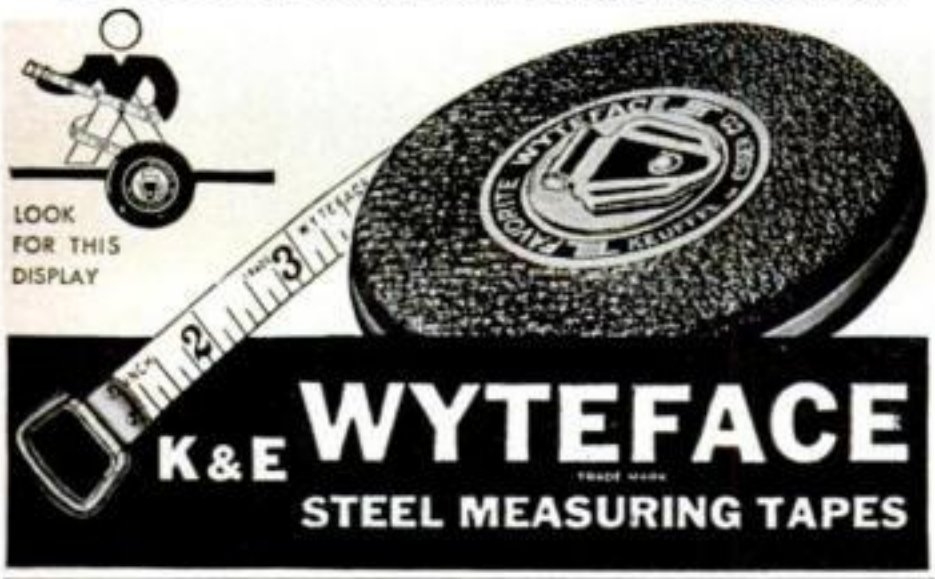
See them at your hardware store, or write for Catalog 35, which describes all Stanley Tools.

STANLEY TOOLS
Division of The Stanley Works, 105 Elm St., New Britain, Conn.
THE TOOL BOX OF THE WORLD

...EASY TO READ

—easy to clean—unconditionally guaranteed for one year. The crack-proof *white* surface is bonded to the steel—protects it from rust. 25, 50, 75, 100 ft. lengths. Sold by hardware, building material, mill supply dealers everywhere. Write for folder.

KEUFFEL & ESSER CO., Hoboken, New Jersey



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MOTO TOOL

100 Tools in One

- Has shock-proof bakelite case
- Fan-cooled motor can't overheat
- Has oil-less bearings
- Dynamically balanced armature

Here's guaranteed quality! The handiest tool in the shop or home. Use it daily for model making, repairing, carving wood or plastics, etching glass or metal, touching up dies, sharpening, routing, sanding, drilling, and on a hundred other jobs. Higher speed does better work and saves cutters. **Model One**, wt. 6oz., with chuck and 1/8" collet, only $9.95. **Model Two**, wt. 13 oz., $16.50. **10 DAY TRIAL**—Money-Back **Guarantee.** If your dealer does not have Moto-Tool, order direct . . . we pay postage if you send cash. Or, send only $1, pay postman balance plus postage. New catalog of tools and accessories **FREE.**

KIT NO. 1 with 23 high grade accessories and Model 1 Moto-Tool in hardwood case $17.50

KIT NO. 2 same as above with Master Model 2 Moto-Tool.... $23.50

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BARRON ROTARY WOOD PLANER

TRUES UP · PLANES · PANELS · RABBETS
ROUTS · TENONS · $7.50 COMPLETE

A WONDER TOOL

Saves hours of tedious hand planing. Parallels and surface finishes to absolute smoothness all knotty and tough grained woods. Hi-Speed, double edged cutter blades insure extra long wear. Unexcelled for paneling, rabbeting, routing, tenoning, grooving, beading and many other workshop uses. Safe—harmless to drill press. Thousands now in use.

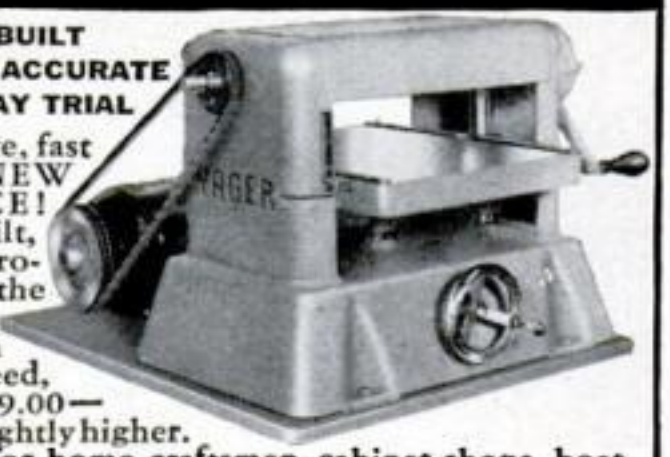
MONEY BACK GUARANTEE Shipped prepaid on receipt of check or money order for $7.50—or C.O.D. Full five day trial and refund guaranteed if not completely satisfied. YOU RISK NOTHING.

BARRON TOOL CO., 362 ARCHITECTS BLDG., DETROIT

FREE FOLDER

LOW PRICE PLANER

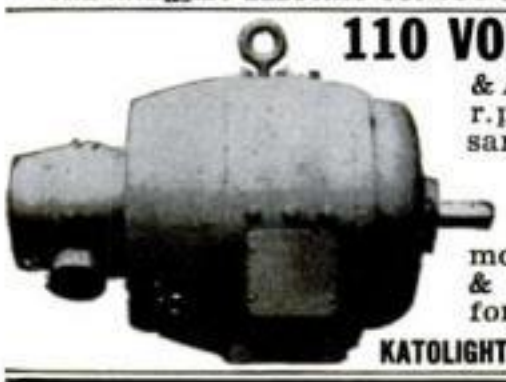
- PRECISION BUILT
- EXTREMELY ACCURATE
- FREE SIX-DAY TRIAL



Here's accurate, fast planing at a NEW LOW PRICE! Precision built, designed for production work, the Yager Bench Planer, with hand crank feed, costs only $99.00—power feed slightly higher. Money-saver for home craftsmen, cabinet shops, boat builders, pattern shops — any woodworking plant. Weighs 125 lbs., uses ½ h.p. motor, has ball bearing cutterhead. Write for folder and details *free six-day trial.*

THE KNEISLEY ELECTRIC CO. 496 SO. ST. CLAIR ST., TOLEDO, O.

110 VOLT AC GENERATORS



& AC light plants, 1200 & 1800 r.p.m., furnish AC current same as in city. 350 to 15,000 watts, list $44.50 & up. Also rotary converters, frequency changers. DC motors with AC take-off, AC & DC generators, etc. Write for circulars.

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We can buy it for you

IN THAT DISTANT CITY

through Western Union Shopping Service. You describe it . . . . we will buy it and see that it is shipped to you promptly. Ask for details at any Western Union office.

NEW Grinding Attachment

For 8" to 16" Metal Lathes. Build It Yourself.

At last, a precision grinder within your means. You save 2/3 by finishing our semi-machined castings, on your own lathe. HURON handles both *internal* and *external* grinding. Accuracies to .00025". Mirror finish easily obtained. Grinds *valves, pistons, bushings, shafts,* hard or soft, *holes, lathe centers.* Sharpens *reamers, milling cutters.* Does *eccentric drilling; laps; polishes;* scores of other uses, for home workshops, garages, machine shops. Write for *FREE* illustrated folder and price list of supplementary items. Mention your lathe.

Semi-Machined Castings Only $6.45

Huron Machine & Tool Co., Dept. C-2, Yale, Mich.

OWN A Printing Business

Cards, Tickets, Stationery, etc. Good profit in spare time. **PRINT YOUR OWN** greeting cards, movie titles, church work, etc. Save money. **Easy rules supplied. Junior Press $8, Senior Outfits $16 up.** Have home shop. Raised printing like engraving too. Sold direct from factory only. Write for free catalog and all details. **KELSEY, INC. X-33, MERIDEN, CONN.**

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Shows hundreds of radio parts, sets, accessories, amplifiers, ham gear, electric appliances and supplies. Rock bottom prices, fast service, guaranteed quality. Send for your copy today. Save at Radolek!

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BUILD YOUR OWN

ARC·WELDER

For Light or Heavy Work

No rewinding necessary—use coils taken from old auto generators. Works on 110 or 220 A.C. Has 20 different heats. Complete plans & Catalog 35c.

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STOP Scratching

Relieve Itch Fast -or Money Back

For quick relief from itching of eczema, pimples, athlete's foot, scales, scabies, rashes and other externally caused skin troubles, use world-famous, cooling, antiseptic, liquid D. D. D. Prescription. Greaseless, stainless. Soothes irritation and quickly stops the most intense itching. 35c trial bottle proves it, or money back. Ask your druggist today for **D. D. D. PRESCRIPTION.**

Build Your Sailboat Now for More Vacation Fun

NOW is the time to start building that boat for your summer vacation. Glorious days on the water are yours with the 19′ cruising sailboat pictured above. It's a cozy, sea-going home, yet it can be carried on a two-wheel automobile trailer. Use an outboard engine, or let the free wind take you places! Blueprints and instructions are only $2.00. Full-size patterns are drawn to order within ten days at $3.50 for the set. Both blueprints and patterns will be sent for $5.50.

For a landlubber's vacation, don't overlook our outdoorsman's trailer. It's 10′ long, 4′ wide, and has a kitchenette on the back. Blueprints and instructions are only 75 cents. Plans for all sorts of other projects also are available. The following is only a partial list. Send a stamped, self-addressed envelope if you wish to have our complete blueprint catalog.

BOATS

All-Purpose Boat, 11′ 5″ long, 331-R	$ .75
Cabin Cruiser, 17′ long, weighs 750 lb., may be used with 2 to 10 h.p. outboard or inboard motors, 356-357-358-359-R	1.50
Canvas-Covered Duck Boat, 13′ 6″ long, 279-R	.50
Family Runabout, 13′ 5½″ long, weighs 275 lb., for outboards from 1 to 60 h.p.; can also be rowed, 378-379-380-R	1.50
Fisherman's Outboard Boat, 9′ 3″ or 11′ 6″ long, weighs 115 or 160 lb., for motors from 3 to 16 h.p.; can also be rowed, 344-345-R	.75
High-Speed Boat for small outboard motors, 7′ 11″ long, 46¾″ beam, 257-R	.50
Inboard Boat, 15′ long, for motors from ½ to 5 h.p.; can also be rowed, 384-385-R	.75
Lapstreak Skiff, 13′ 9″ long, weighs 225 lb., for 1- to 16-h.p. outboard motors, 363-R	.50

(Continued on page 232)

Plans for Tested Projects

(Continued from page 231)

Motorboat-Rowboat, 13′ long, decked hull, for use with outboard or inboard drives, 147-R	.50
Same, 14½′ long, 148-R	.50
Same, 16′ long, 149-R	.50
Plywood Dinghy, 9′ 7″ long, weighs 60 to 75 lb.; can be rowed, sailed, or used with small outboard motor, 387-388-R	.75
Racing Runabout, 13′ stepless hydroplane for outboard motor, 261-262-R	.75
Racing Sailboat BLACKCAT, 13′ 4″ long, weighs 250 lb., Marconi rigged, 321-322-323-R	1.00
Runabout, 15′ 6″ long, weighs 550 lb., can be used with outboard or inboard motors of from 1 to 60 h.p., 175-176-177-R	1.00
Sailboat, 12′ long, weighs 200 lb.; has fast skimming-dish hull, 314-R	.50
Sectional Rowboat, 9′ 8″ long, two sections, weighs 60 lb., all-wood construction; can be used with small outboard motor, 340-341-R	.75
Sport Runabout, 9′ 8″ long, for small outboard motor, weighs 100 lb., 309-310-R	.75
Utility Rowboat, 13′ long; can also be sailed or driven by outboard motor, 224-R	.50

FURNITURE

Apartment Fireplace, 312A	.25
Bookcase for holding copies of Popular Science Monthly, 353A	.25
Drafting Table, 189A	.25
Four-Leaf Card or Occasional Table, 239A	.25
Gate-Leg Table, 3′ 6″ diameter, circular top with leaves up, no turning, 24	.25
Tile-Top Tables (wood and metal), 249A	.25
Welsh Dresser, 6′ high, no turning, 60	.25

MODELS

BLUENOSE, famous fishing schooner, 17½″ hull, 110-111-112-R	1.00
Concord Stagecoach DIAMOND TALLY-HO, 20½″ long, 115-116-117-R	1.00
Confederate Raider ALABAMA, 21½″ hull, 335-336-337-R	1.50
Liner QUEEN MARY, 10¼″ hull, 283	.25
NOURMAHAL, power yacht, 8⅛″ hull, 276	.25
Ocean Freighter, 14″ hull, 271	.25
U. S. Battleship TEXAS, 3′ hull, 197-198-199-200	1.00

MISCELLANEOUS

Bronze Hammer, Rolled-Edge Metal Tray, Table Centerpiece for Easter (rabbit hitched to wagon), 407A	.25
Five-Piece Desk Ensemble (letter rack, blotter, letter opener, etc.). Nautical Lamp (resembles engine-room telegraph), 410A	.25
Folding Wall Brackets (turned), Treble-Clef Bud Vase (metal or plastic), Vacuum Cleaner Attachment Rack, 408A	.25
Turned Costume Jewelry and Solid Model of Argonaut Pirate Flying Boat, 275A	.25
Workbench for Home Shop, 24″ by 58″ by 34¼″ high, 405	.25

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Garden Fireplaces. Furniture, and Pools	.35
Hints on Cutting and Drilling Glass	.15
How to Build and Operate an Inexpensive Arc Welder and Spot Welder	.50
Home Workshop Index for 1940	.10
Home Workshop Index for 1941	.10

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353 Fourth Avenue, New York, N. Y.

Send me the blueprint, or blueprints, numbered as follows:

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I am inclosing.....dollars.....cents

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City and State .....
(Please print your name and address very clearly.)

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say HARLEY-DAVIDSON RIDERS

Defense plants are going 24 hours a day. Thousands upon thousands of men work on staggered schedules and night shifts. But the fellows who own dependable Harley-Davidsons never have to worry about transportation. Day or night their powerful Harley-Davidsons take them to and from their jobs quickly and at low cost. No traffic tie-ups or parking worries for them. And more miles per gallon and minimum oil consumption conserve precious gas and oil for vital defense needs.

Harley-Davidson motorcycles are doing double duty these days — in defense service as well as for civilian needs. See your Harley-Davidson dealer—learn about the superior performance of these world champion motorcycles. Also look over his special values in reconditioned models.

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Send FREE copy of big 24-page "Enthusiast" magazine filled with thrilling motorcycle pictures and stories. Also literature on the latest Harley-Davidsons. Stamp is enclosed for mailing cost.

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CHEMICAL KITS and APPARATUS OUTFITS FOR STUDENTS, BIG VALUE. FREE LITERATURE and CATALOG of CHEMICALS & LABORATORY SUPPLIES. Send 3c for return postage.

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SAVE! PRECISION BUILT HOME WOODWORKING MACHINERY NOW AT LOWEST PRICES!

Better built for heavy duty work just like this new streamlined Blue Star Lathe. It's a big lathe, 48" structural steel bed, 10" tool rest, Sealed ball bearings, 4-Step Pulley, V-Belt and dozens of other fine features all at amazing low prices. A complete line of accessories, too. Write to-day for big Blue Star Book of precision built equipment . . . the kind you've always wanted to own. See the money-saving prices.

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SAVE 60% OR MORE BY assembling your **FLUORESCENT FIXTURES** For HOME, WORKSHOP, STORES, OFFICES AND FACTORIES

UTILITY LIGHT COMPLETE KIT
$1.95 BULB 75c Extra
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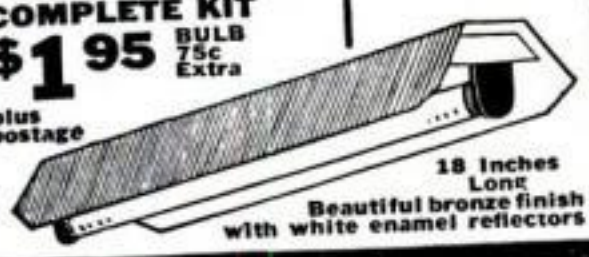
Anyone can assemble. Complete instructions furnished. All metal parts beautifully finished. Newest starter type electrical equipment fully guaranteed by us.



18 Inches Long
Beautiful bronze finish with white enamel reflectors

New shadowless, glareless light everyone is talking about, recognized as the greatest improvement in lighting since Edison discovered the electric lamp, can now be yours at a fraction of the regular cost. Your fluorescent light will give you twice the light of your incandescent bulb with less eye strain while using only one half the electricity. This will etable you to cut your light bill in two.

Fluorescent lighting offers the greatest opportunity in America today for young men to establish themselves in their own business as trained sales and service men. Fixtures pictured on this page are now retailing for $5.50 to 10.00. Write now for complete details to learn how you can establish yourself in a very profitable business assembling and selling our complete line of Fluorescent fixtures. **Be the first in your town.**

NATIONAL FLUORESCENT SALES AND SERVICE COMPANY
404 North Wells Street **Dept. A** **Chicago, Illinois**

Modern wall and ceiling fixture.
Complete kit
$2.75
plus postage
BULB 75 cents extra
Polished metal end caps. White enamel body. Price includes switch

Now **YOU**, *too, are invited to Share the Record Profits in Fluorescent Lighting! New Assembling-Servicing Plan Brings you LOWEST Prices.*

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NATIONAL FLUORESCENT SALES & SERVICE CO., Dept. A.
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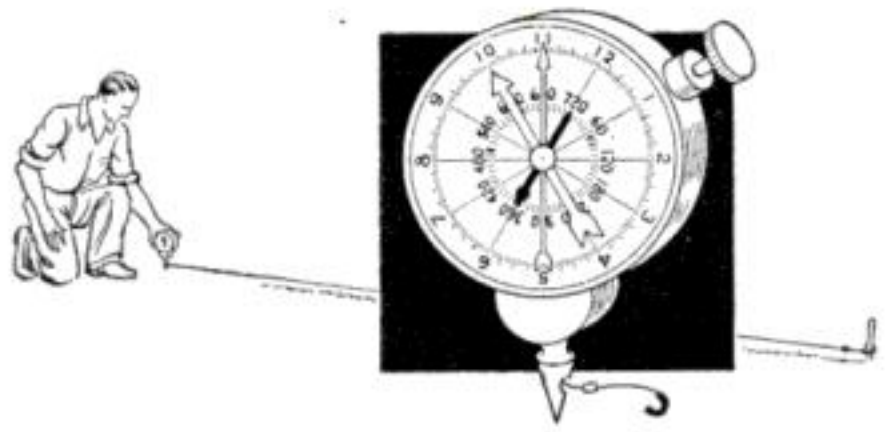
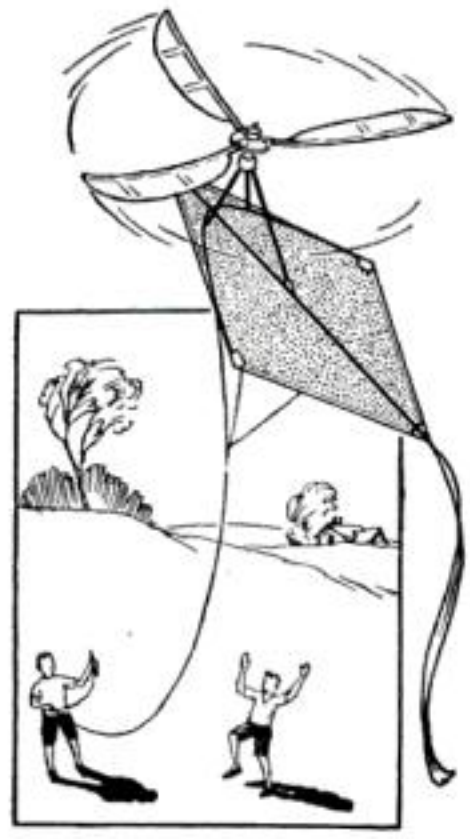
WRITE FOR FREE CATALOG

With the Inventors

BY COMBINING the basic parts of a watch and a fishing reel, Joseph V. Keenan, of Fort McIntosh, Tex., has produced a device to measure distances of hundreds of feet to within a small fraction of an inch. The largest of three hands on a



dial moves continuously, making a complete revolution when a foot of line is paid out. It then advances the next smaller hand one segment, or to the "one o'clock" position. Likewise, this hand, which completes a revolution in 12 feet, intermittently advances the smallest hand one segment at a time. Corresponding scales make the compact precision instrument easy to read at a glance. In the accompanying sketch, for example, it indicates ten feet and 11 inches; the smallest hand is at the zero point, which coincides with the maximum reading of 720 feet. After completing a measurement, the user simply presses a convenient button, and a spring mechanism throws all the hands back to zero. . . . A "ROTOR KITE" that behaves much like an autogiro offers a novel toy for children, in a design patented by Manuel Carrasco of New York City. Revolving blades of paper or light metal, mounted upon a lightweight framework of bamboo, contribute to the "lift" of a conventional kite design. According to the inventor, they also minimize its tendency to take uncontrollable side swings. When the kite is flown, as shown in the illustration, the rotor part revolves in a clockwise direction, and gives a striking appearance from the ground. In consequence, the toy



(Continued on page 237)

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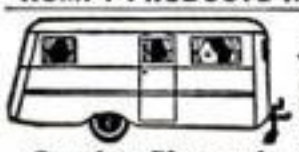

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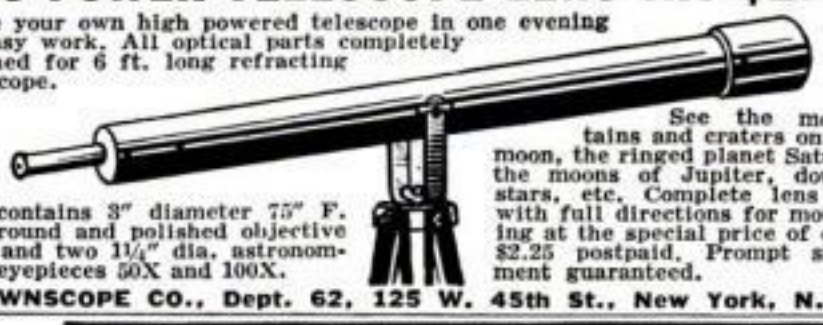

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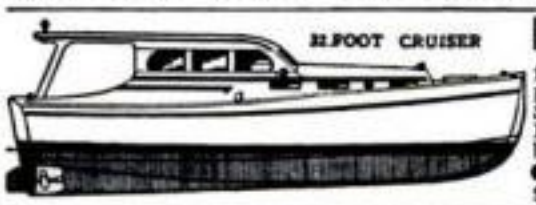

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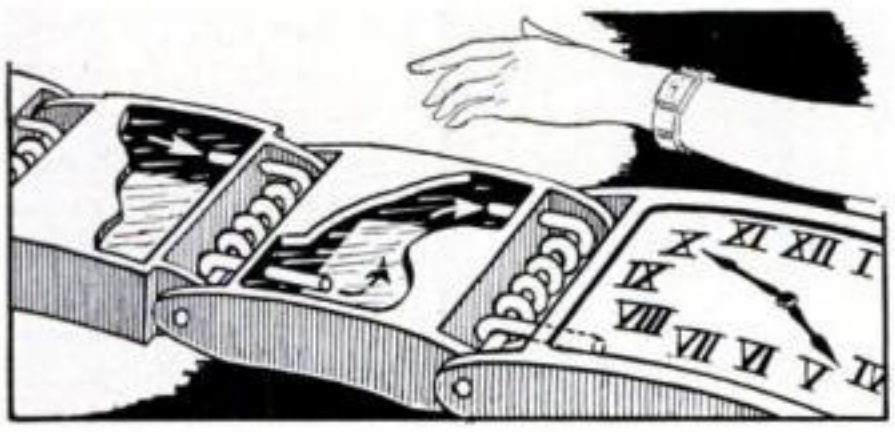
With the Inventors

(Continued from page 234)

may also be adapted for commercial purposes, by imprinting advertising matter upon the lozenge-shaped wing that constitutes the main supporting surface. . . . A PARACHUTE BUILT INTO A FLYING SUIT gives safety and comfort, in a recently patented design. Stowed in two roomy trousers pockets, it forms a comfortable cushion. Besides the main parachute, the garment contains a small "pilot" parachute, released by the wearer at the touch of a spring, to catch the air and aid in opening the larger one. Still another feature is a cowl-like bag which will serve as a life preserver in the event that the jumper lands in the water. Because of its compactness, in contrast with the conventional parachute pack carried by flyers, the suit enables the pilot to enter readily as cramped a space as the cockpit of a modern pursuit plane. It offers obvious advantages over detachable parachutes, which may well be difficult to don when an airplane is flying upside down, or is spinning out of control. . . . GAS PRESSURE, instead of a mainspring, operates an odd wrist watch recently patented. Hollow links of the bracelet contain the compressed gas in liquefied form. As it gradually vaporizes, it passes through tiny tubular connections from one link to another, and finally into the watch itself.



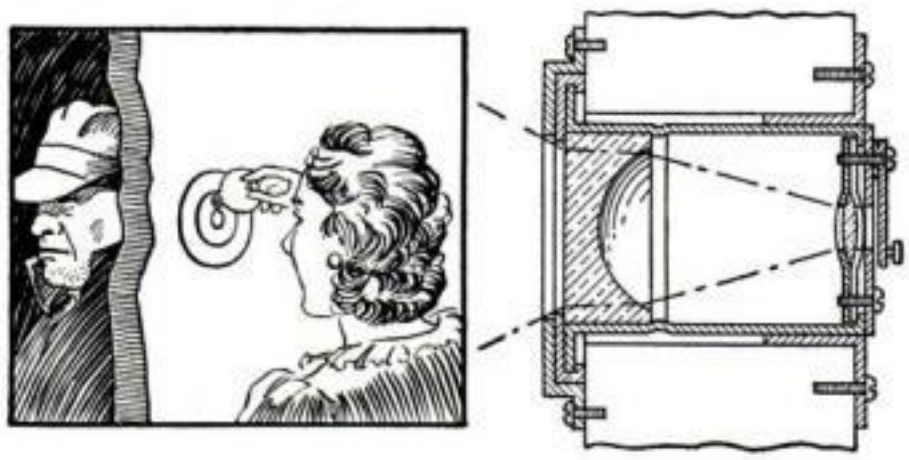
Here, through a piston, it operates a clockwork movement of conventional design. Or, if desired, the pressure of the gas may be used simply to wind up a watch. Recharg-

(Continued on page 238)

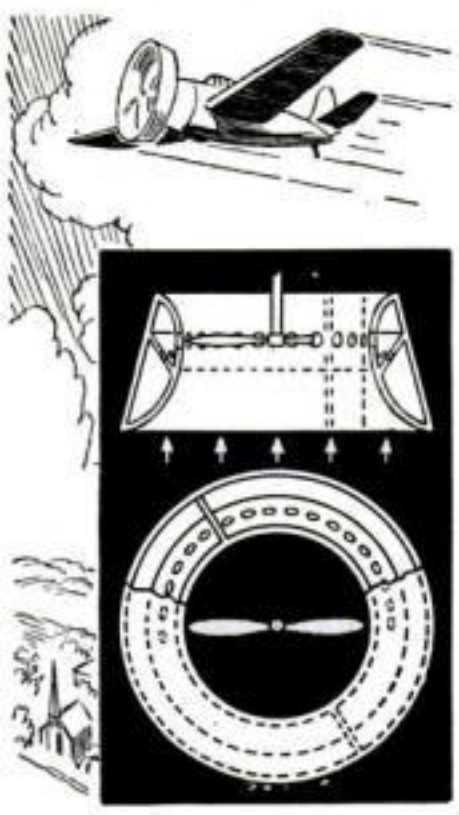
With the Inventors

(Continued from page 237)

ing, necessary only at long intervals, is provided for by a fluid-tight opening. The inventor suggests propane, also used for fuel in rural homes, as the gas to be used. . . .



OPTICAL DESIGN, in a new style of peephole, helps a housewife to inspect tramps and other questionable callers without opening the door. Especially suited for installation in a wall or thick door, the device provides a pair of lenses for increasing the field of view, beyond what a user could see through an ordinary tube of the same length. In the diagram, dotted lines show what would be limiting places to vision, without the lenses. The tiny inner lens serves as an eyepiece, when its swinging cover is lifted, while the other lens is mounted close to the outer end of the viewer. . . . "INAUDIBLE" PLANES may play an important role both in war and peace—in the first case, to make their approach undetected by ground observers, and, secondly, to offer additional comfort to their own passengers. Not everyone knows, however, that the whine of an airplane propeller makes about as much noise as the engine itself. To silence it, E. H. Harris, of New York City, has contrived a sound-absorbing housing, for airscrews. Noise from the propeller passes through holes in the perforated inner wall of the housing, and enters an "impedance chamber" where it is largely absorbed. Through apertures in a dividing partition, remaining sound waves are con-



(Continued on page 241)

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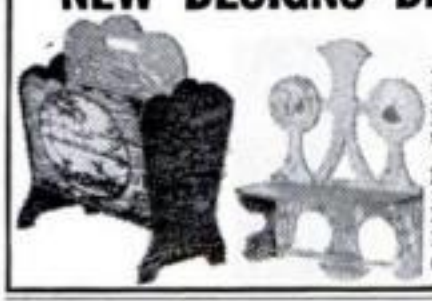

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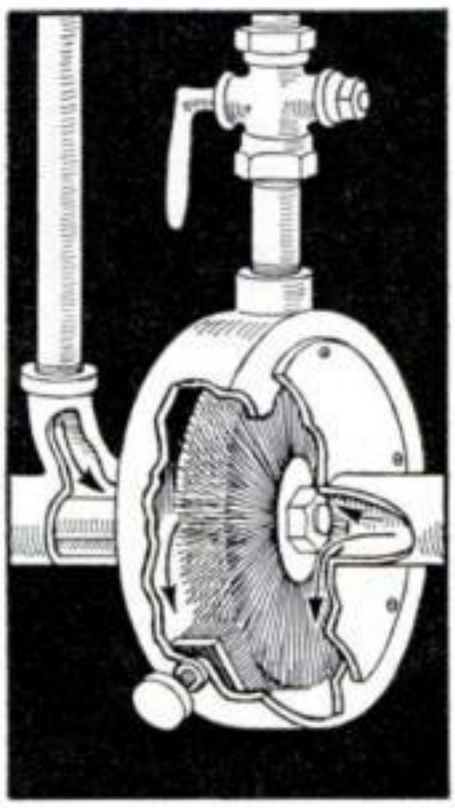
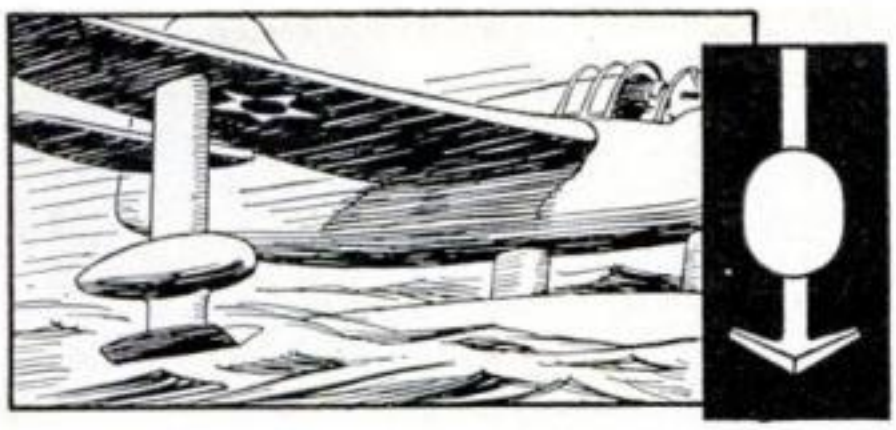
With the Inventors

(Continued from page 238)

ducted into a "resonator chamber" where they completely expend themselves. . . . AN "EMERY WHEEL" FOR CHEMICALS, invented by F. W. Winkler of Newark, N. J., consists of a high-speed rotating brush with bristles of plain steel, stainless steel, or bronze. When a mixture of compounds passes through it, each substance is broken down into extremely fine particles and mixed intimately with the rest. In consequence, reactions ordinarily considered impossible will take place, according to the inventor. His experiments indicate that the device may be used in purifying crude gasoline; preparing precipitated chalk of high quality; and in manufacturing colored pigments called "lakes." Substances difficult to dissolve can be forced to react, without use of expensive solvents. Others can be separated by aerating an oil mixed with them, in a sort of upside-down flotation. . . . BY INVENTING a dual-action wing float for naval flying boats, Commander Walter S. Diehl, U.S.N., solves the problem of combining efficient take-offs with high speed in the air. In a take-off, the planing or skimming action of the float helps bring the plane to an even keel. But floats shaped for best planing effect have been found to offer





the most wind drag, once the craft is aloft; and those with favorable air performance prove inefficient in the water. In Commander Diehl's plan, a V-shaped hydrofoil, added beneath each float, provides the planing action required, while the float proper takes on a full streamline shape.

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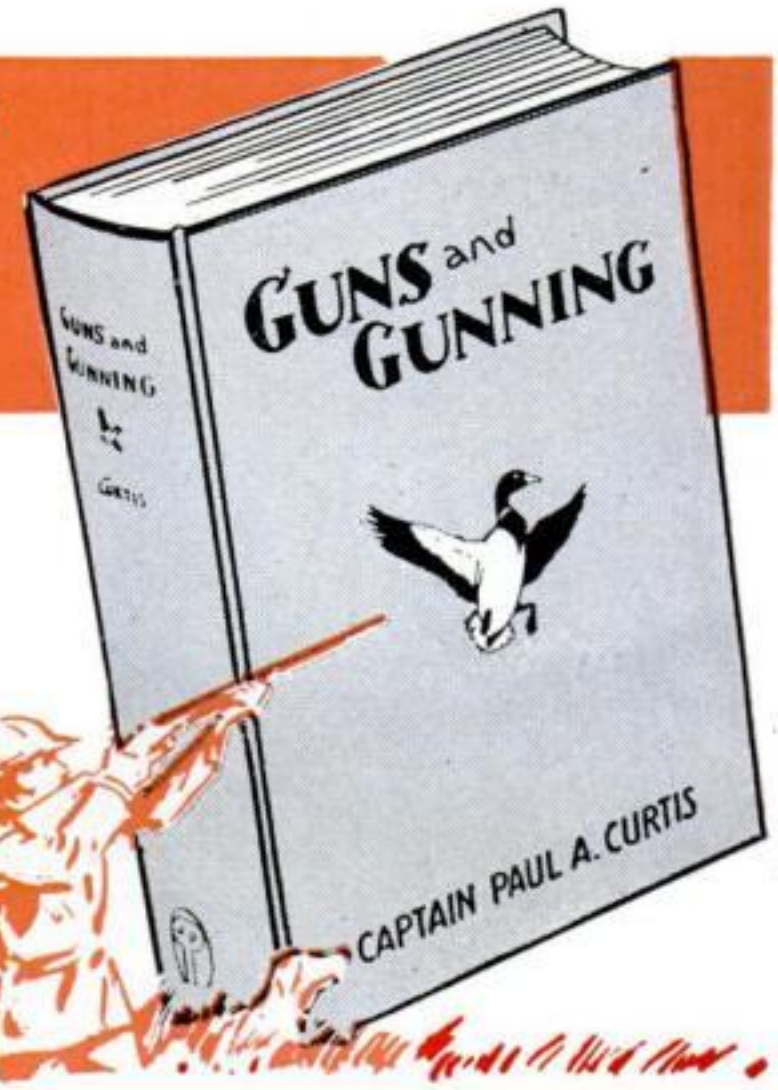

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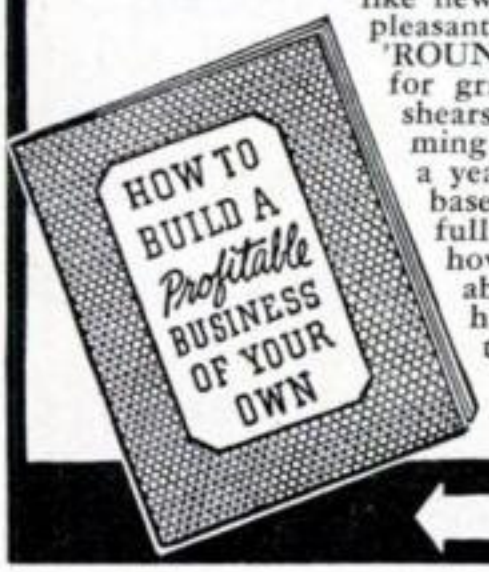

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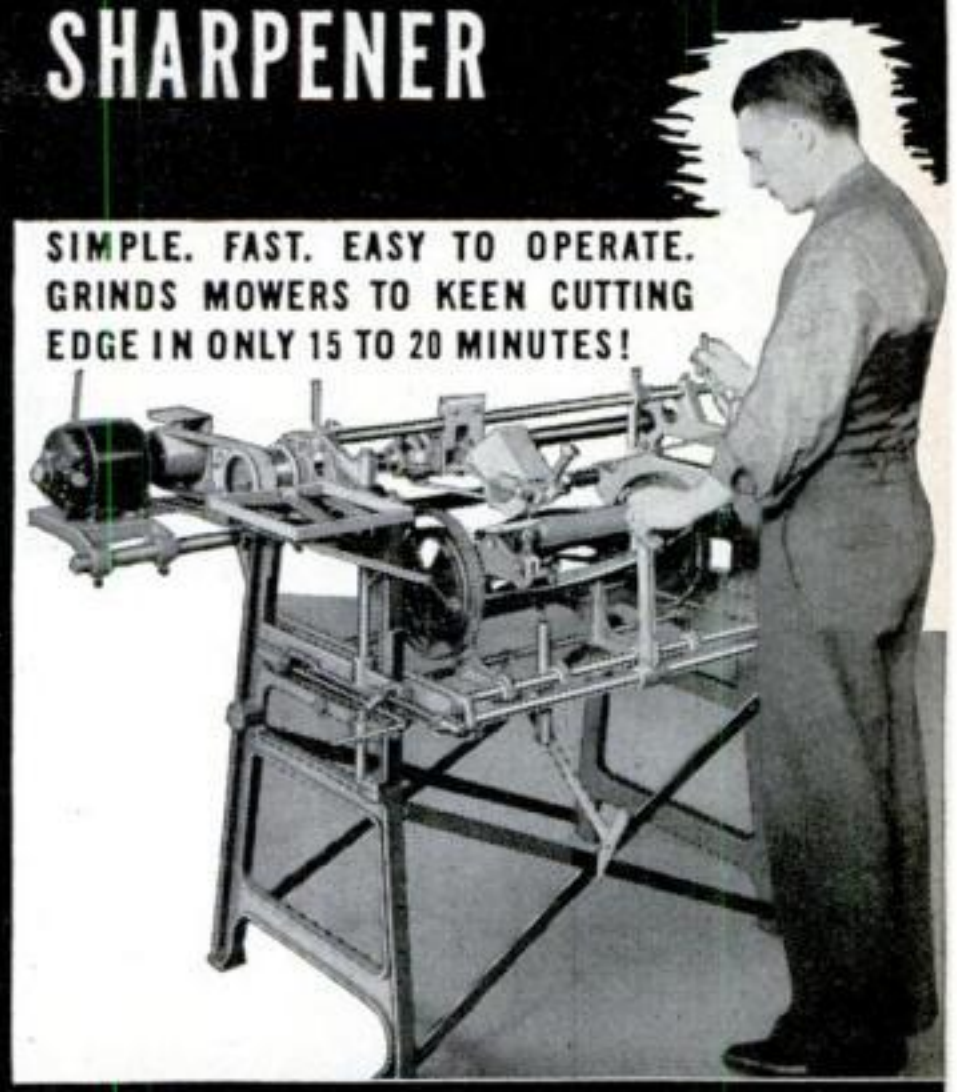

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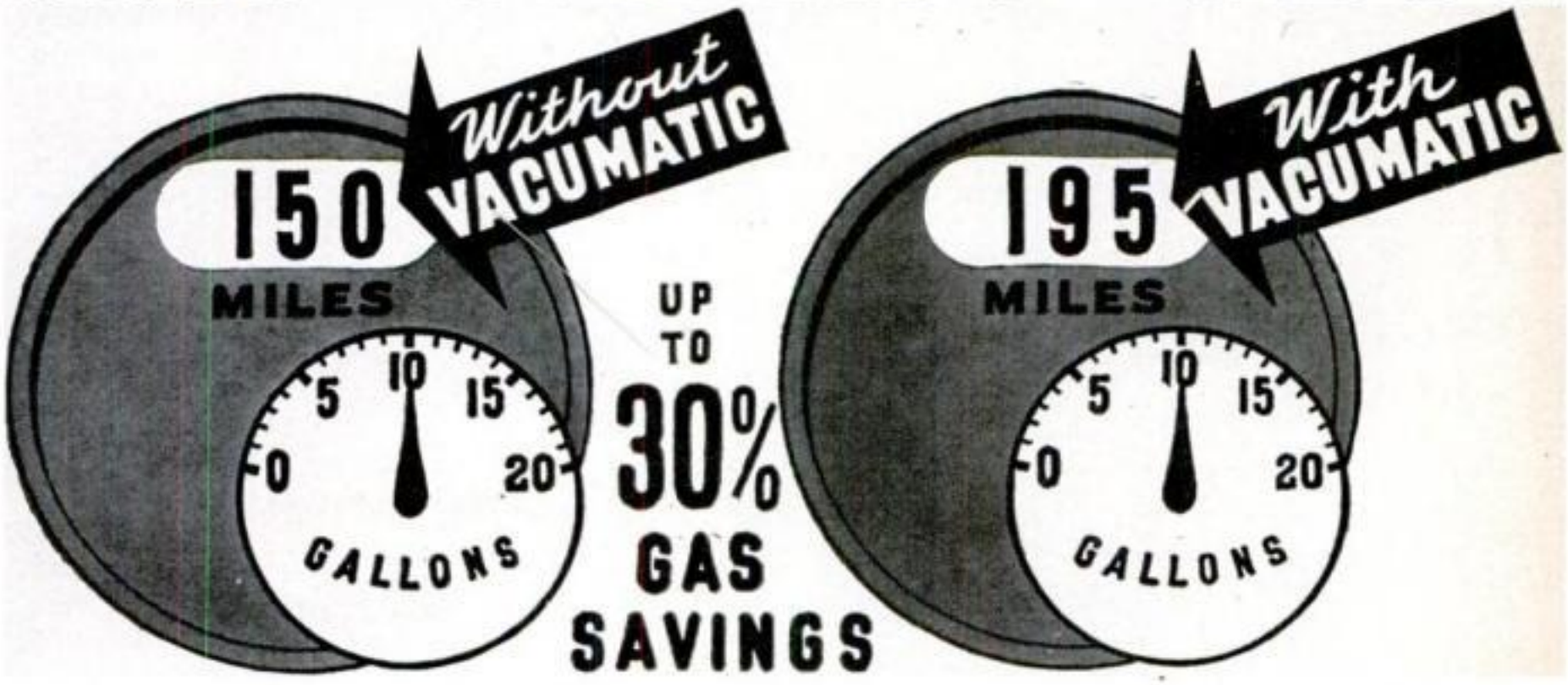

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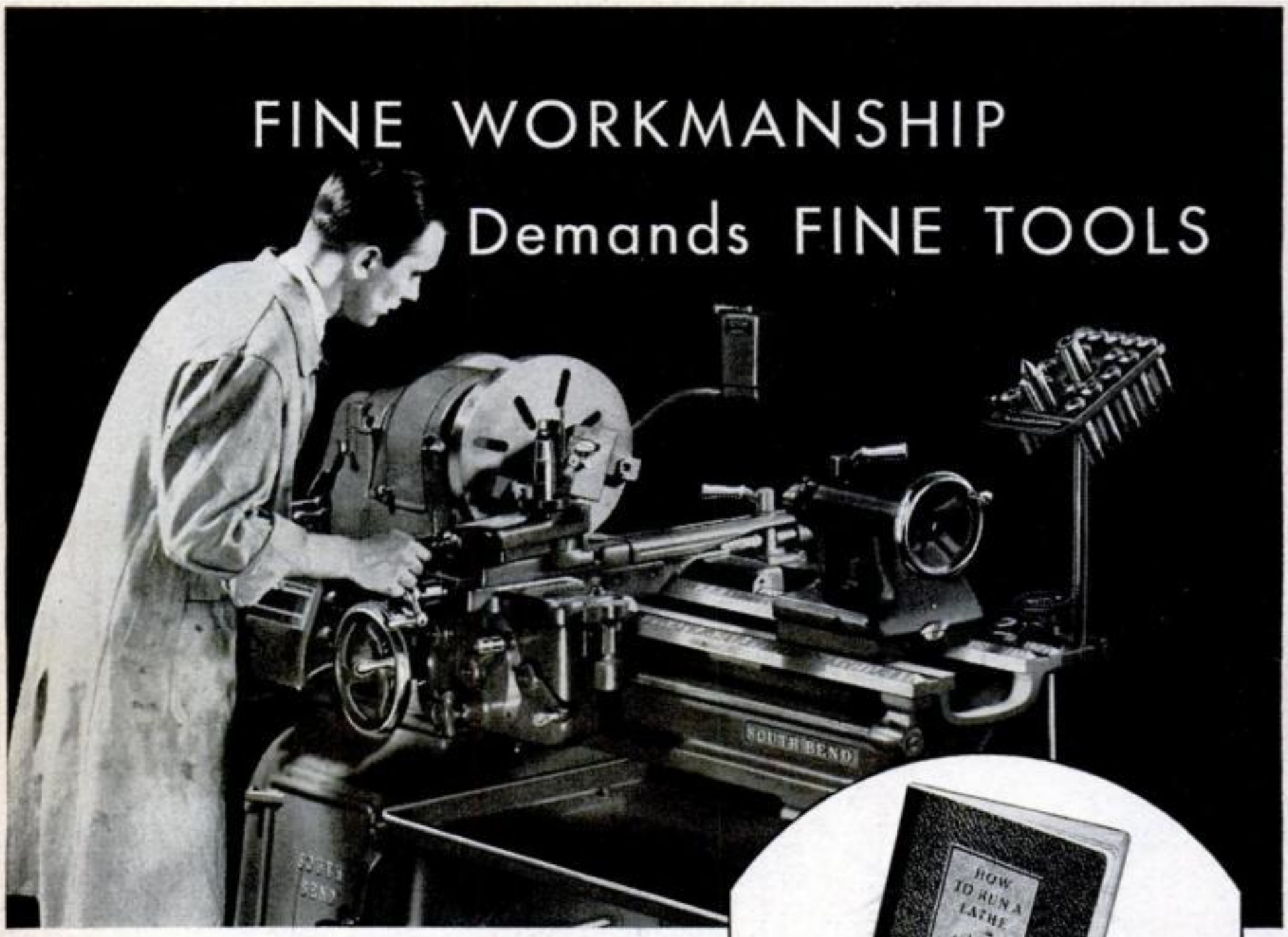

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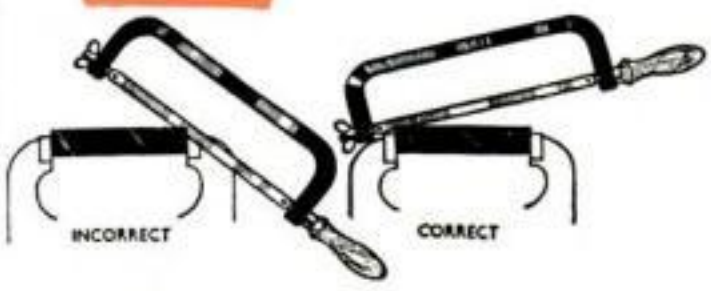

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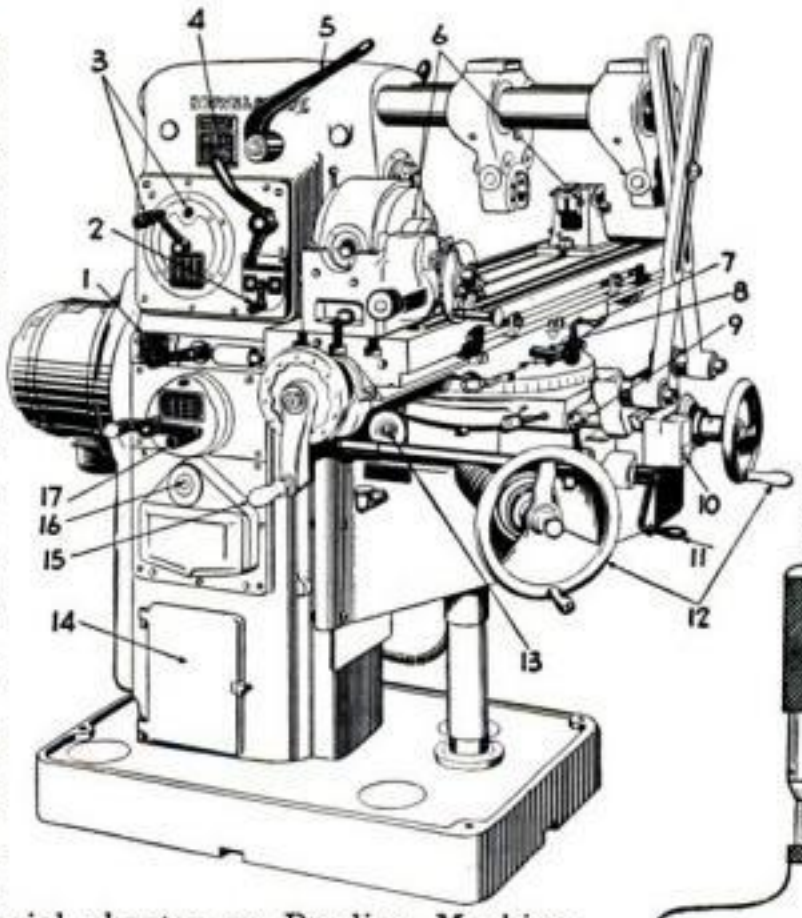

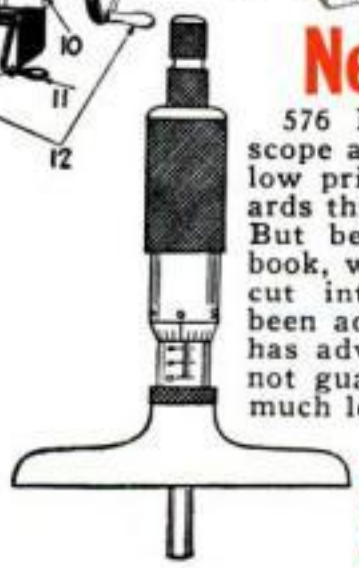

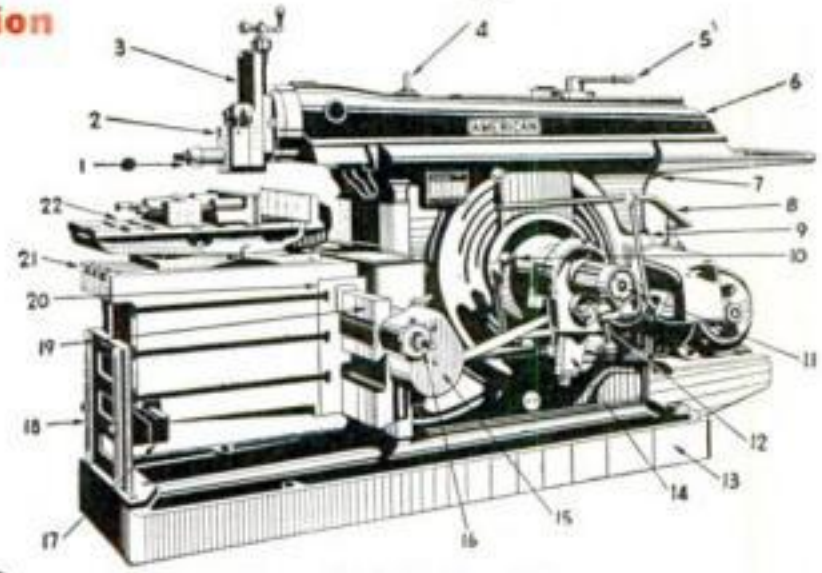

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